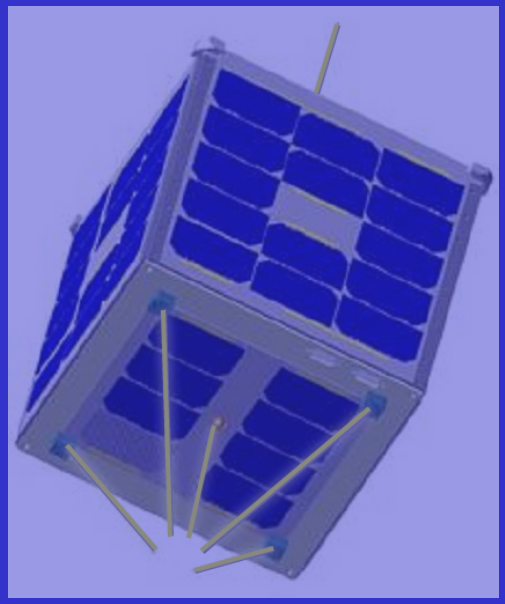
ECHO (AO-51) as an Educational Tool



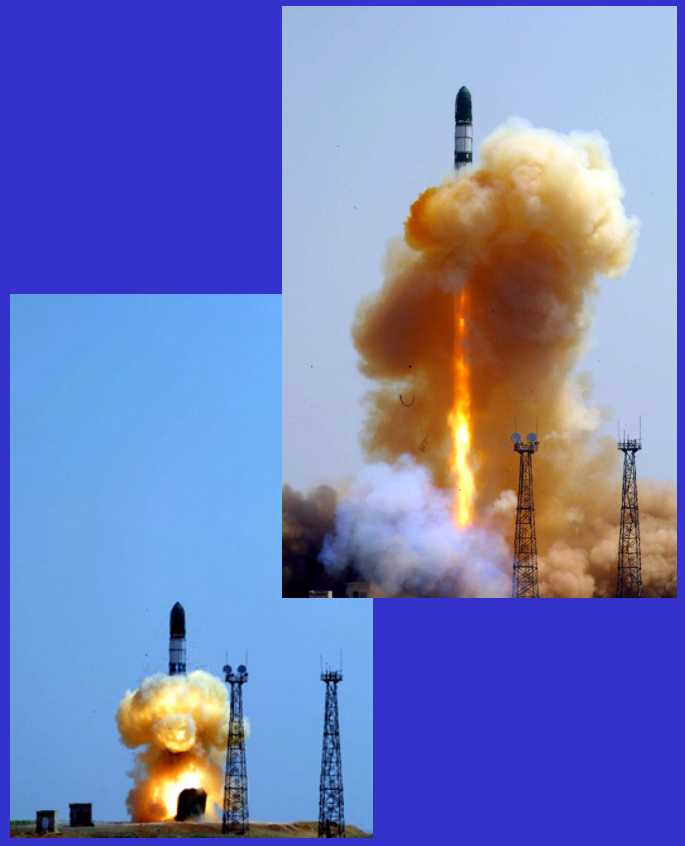
Gould Smith, WA4SXM

2004 AMSAT Symposium

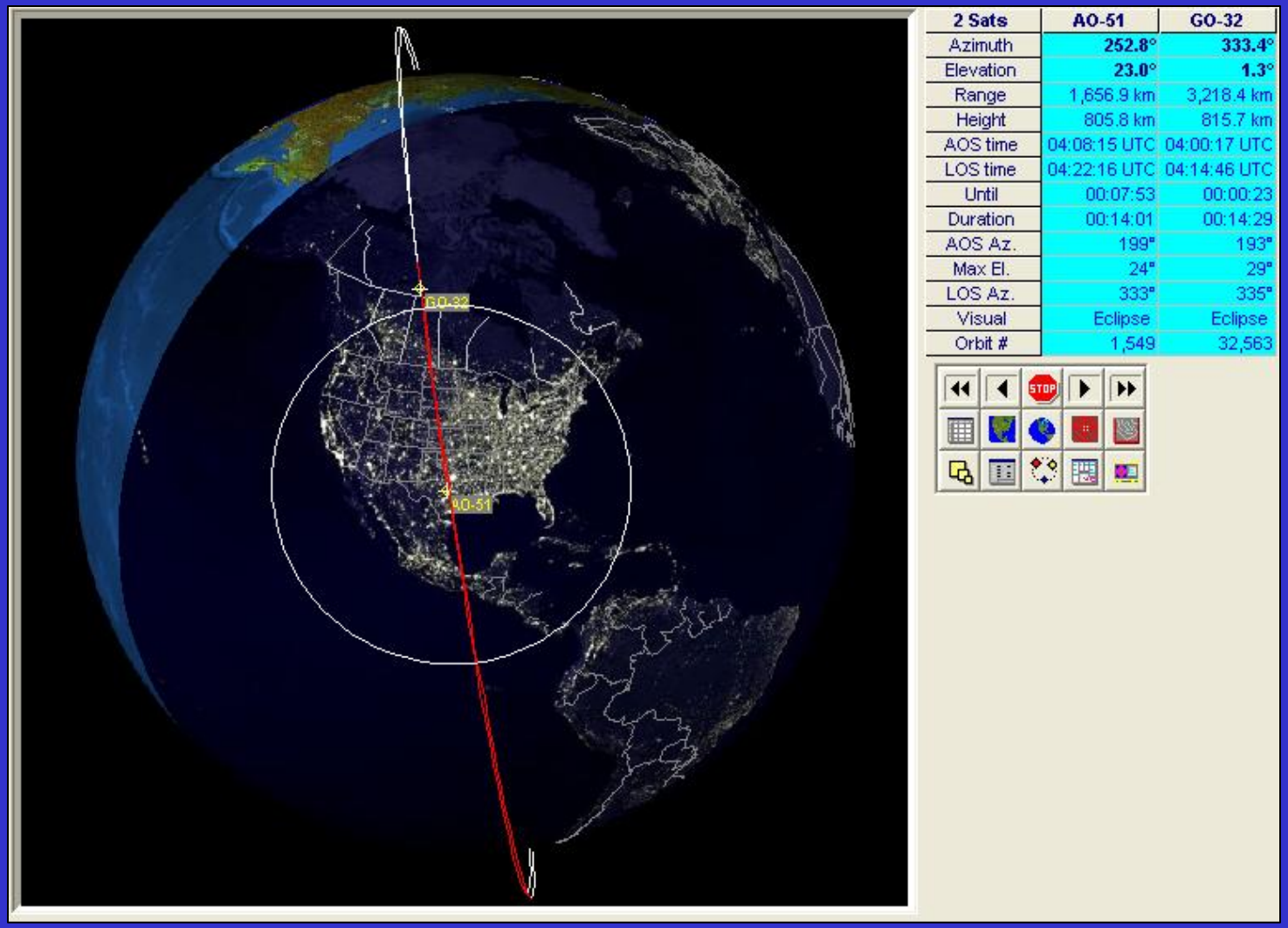
Arlington, VA

ECHO becomes AO-51

- Since its launch into orbit on 29 June 2004 the ECHO satellite has continued to provide, reliable operation on multiple frequencies using multiple communication modes.
- It is now up to us to utilize this impressive resource



AO-51 Orbit

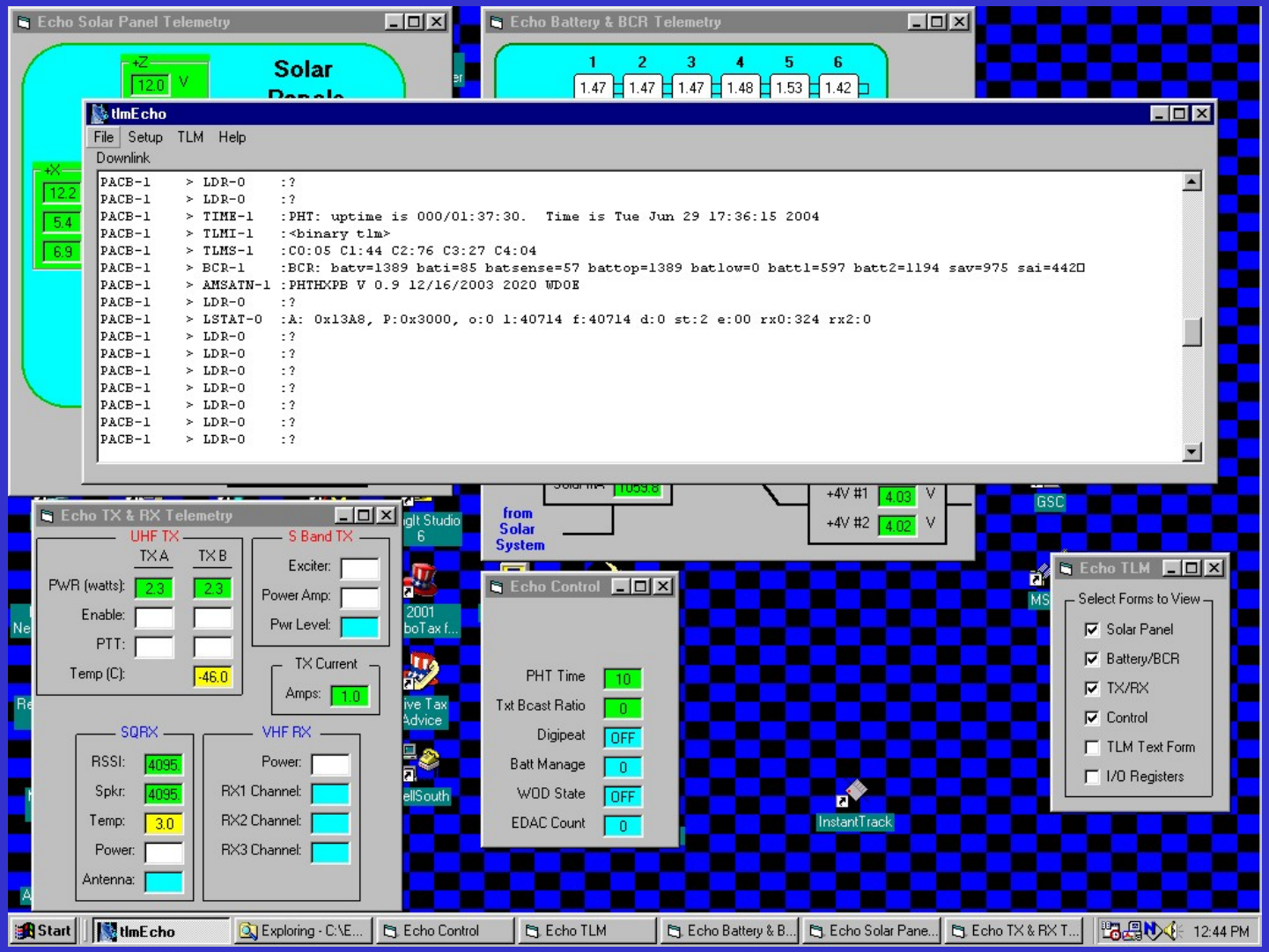


2 Sats	AO-51	GO-32
Azimuth	**252.8°**	**333.4°**
Elevation	**23.0°**	**1.3°**
Range	1,656.9 km	3,218.4 km
Height	805.8 km	815.7 km
AOS time	04:08:15 UTC	04:00:17 UTC
LOS time	04:22:16 UTC	04:14:46 UTC
Until	00:07:53	00:00:23
Duration	00:14:01	00:14:29
AOS Az.	199°	193°
Max El.	24°	29°
LOS Az.	333°	335°
Visual	Eclipse	Eclipse
Orbit #	1,549	32,563

AO-51 Passes

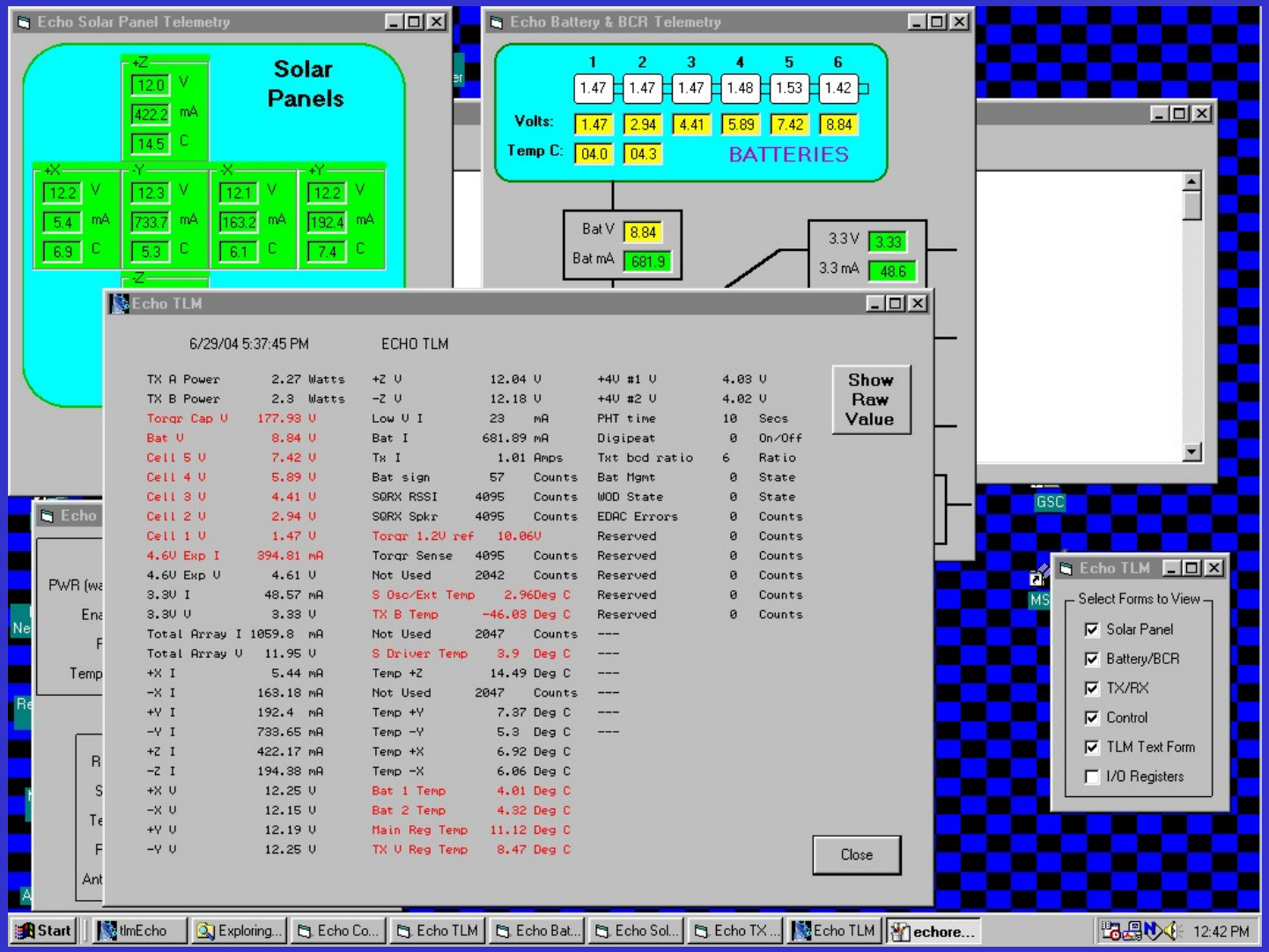
IT
Auto
Satellite Schedule
Day: 05/14/2004 Satellite: ECHO
Station: WA4SXM
Hour - EDT
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
05/14
05/15
05/16
05/17
05/18
05/19
05/20
05/21
05/22
05/23
05/24
05/25
05/26
05/27
05/28
05/29
05/30
05/31
06/01
06/02

AO-51 Telemetry 6/29/04

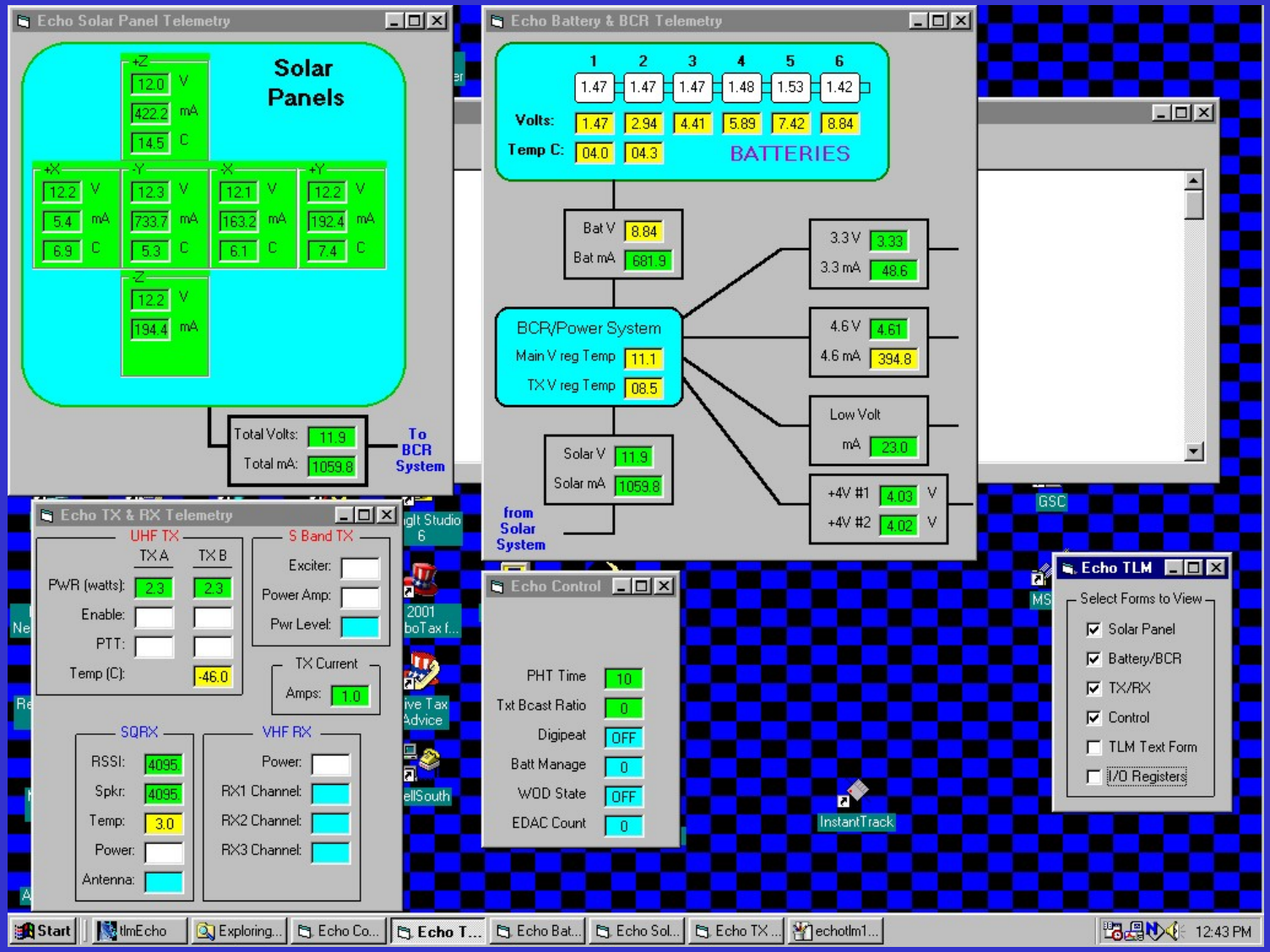


Free telemetry software available for both the PC and Mac platforms

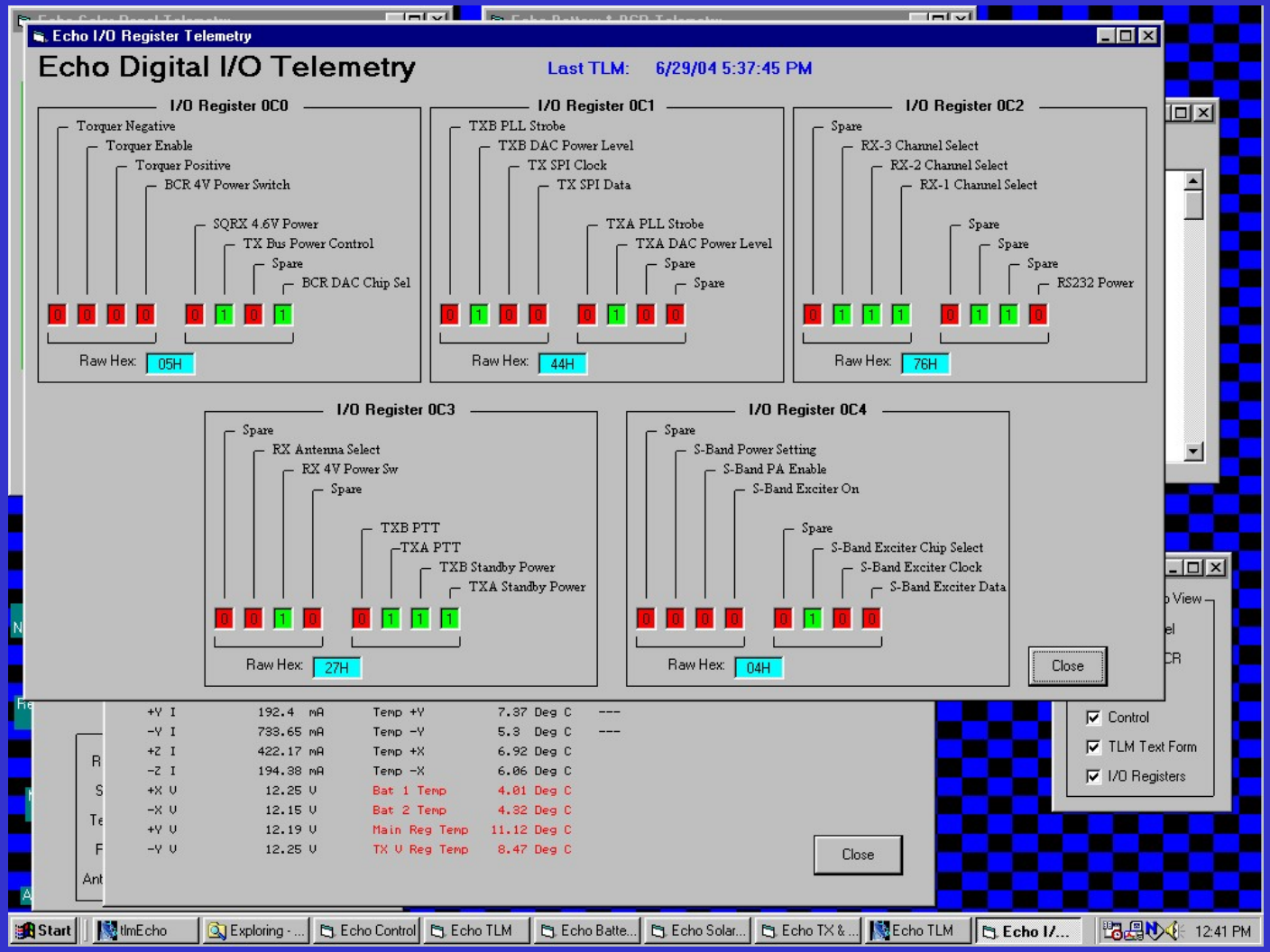
AO-51 Telemetry



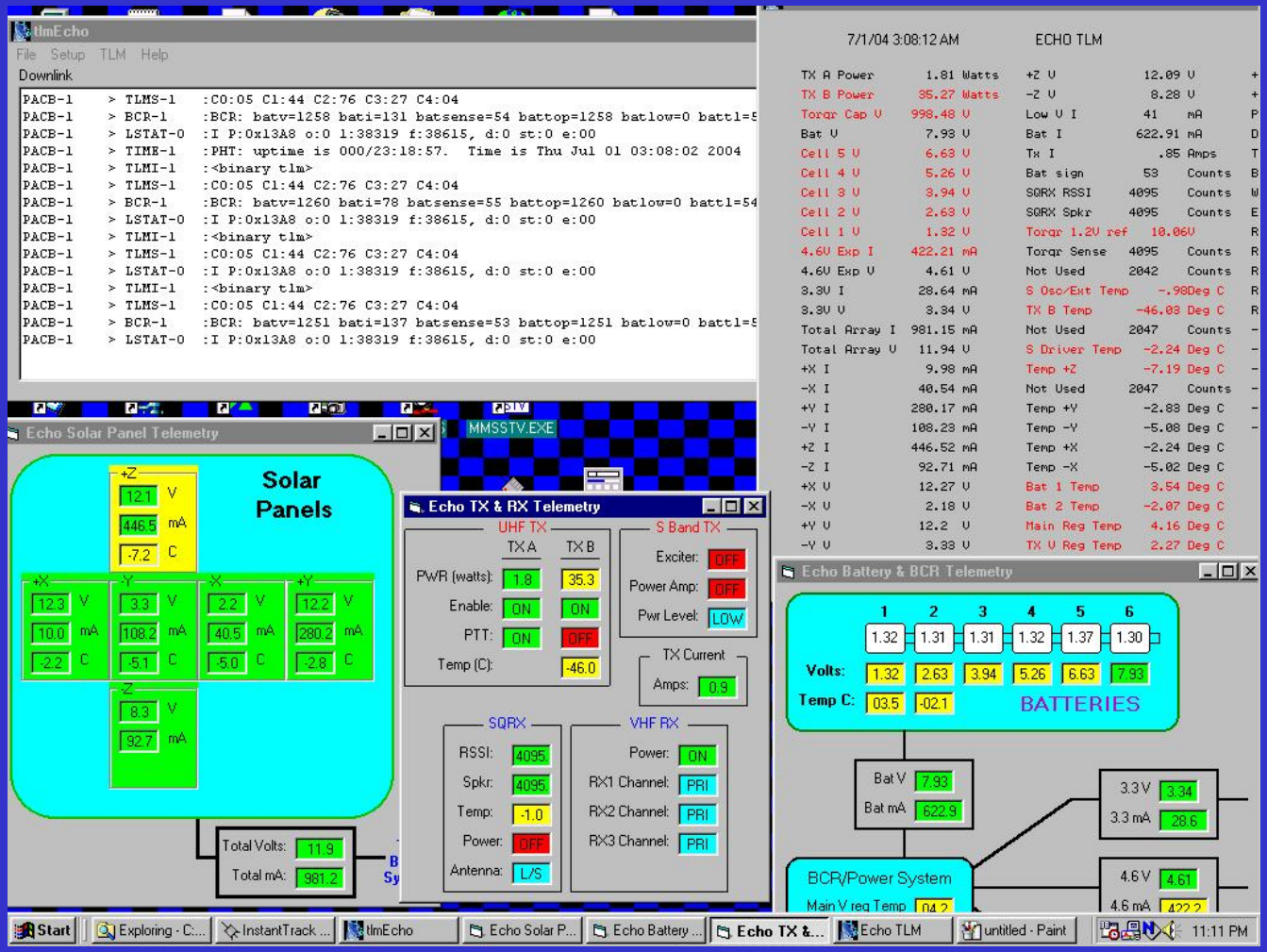
AO-51 Telemetry



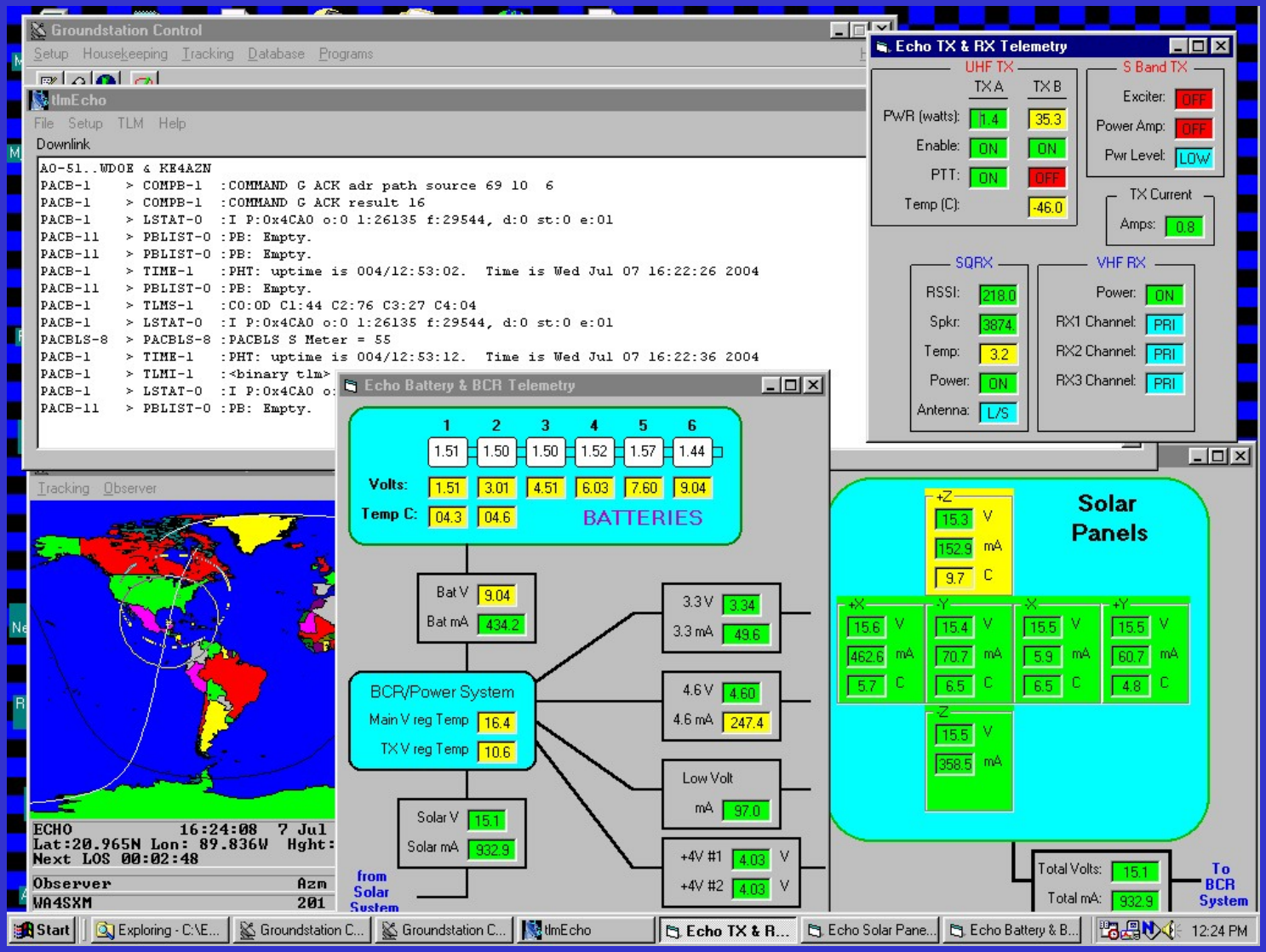
AO-51 I/O Registers



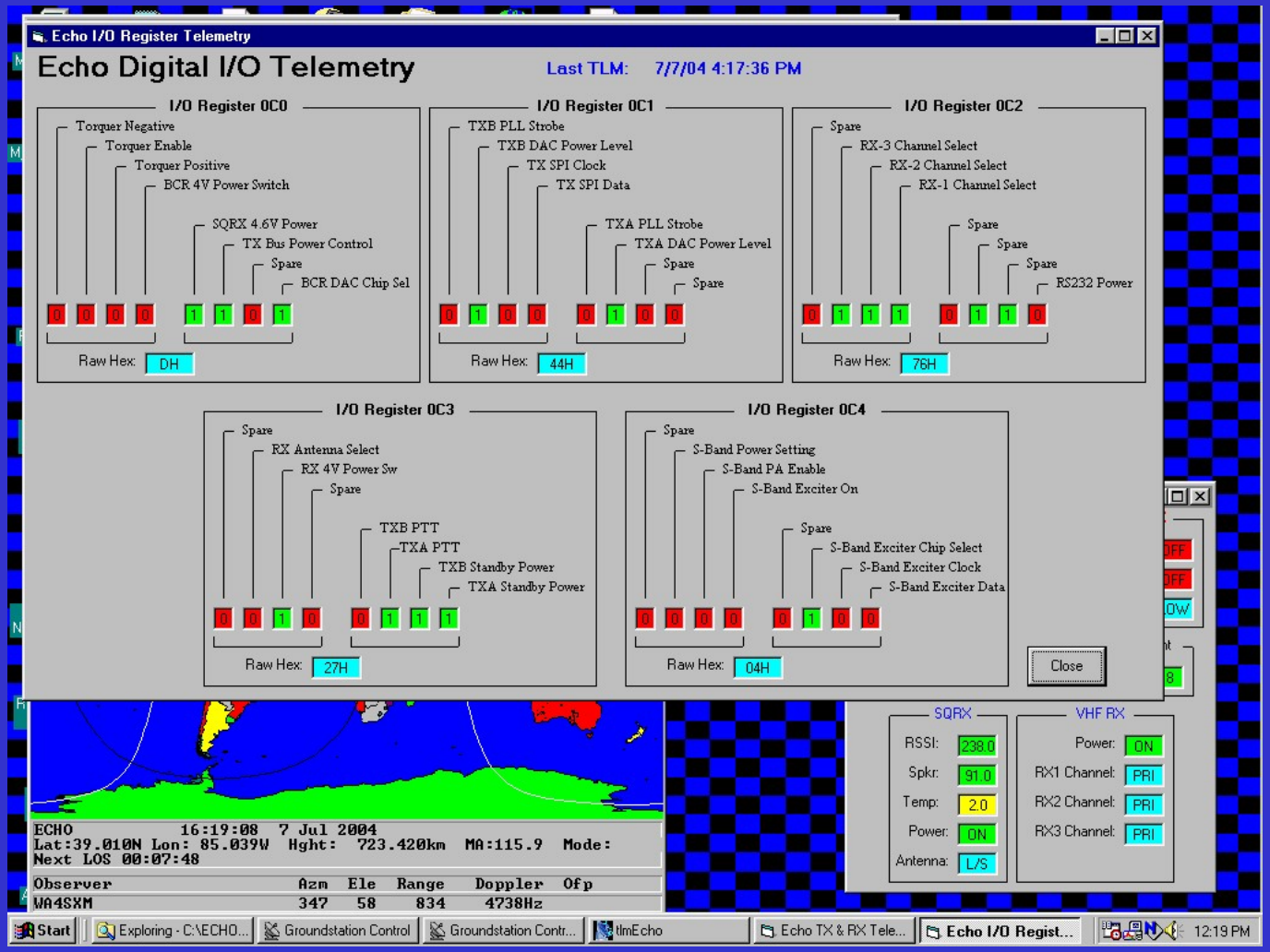
AO-51 Telemetry 7/01


tlmEcho
File Setup TLM Help
Downlink
PACB-1 > TLMS-1 :CO:05 C1:44 C2:76 C3:27 C4:04
PACB-1 > BCR-1 :BCR: batv=1258 bati=131 batsense=54 battop=1258 batlow=0 battl=5
PACB-1 > LSTAT-0 :I P:0x13A8 o:0 l:38319 f:38615, d:0 st:0 e:00
PACB-1 > TIME-1 :PHT: uptime is 000/23:18:57. Time is Thu Jul 01 03:08:02 2004
PACB-1 > TLMI-1 :<binary tlm>
PACB-1 > TLMS-1 :CO:05 C1:44 C2:76 C3:27 C4:04
PACB-1 > BCR-1 :BCR: batv=1260 bati=78 batsense=55 battop=1260 batlow=0 battl=54
PACB-1 > LSTAT-0 :I P:0x13A8 o:0 l:38319 f:38615, d:0 st:0 e:00
PACB-1 > TLMI-1 :<binary tlm>
PACB-1 > TLMS-1 :CO:05 C1:44 C2:76 C3:27 C4:04
PACB-1 > LSTAT-0 :I P:0x13A8 o:0 l:38319 f:38615, d:0 st:0 e:00
PACB-1 > TLMI-1 :<binary tlm>
PACB-1 > TLMS-1 :CO:05 C1:44 C2:76 C3:27 C4:04
PACB-1 > BCR-1 :BCR: batv=1251 bati=137 batsense=53 battop=1251 batlow=0 battl=5
PACB-1 > LSTAT-0 :I P:0x13A8 o:0 l:38319 f:38615, d:0 st:0 e:00
7/1/04 3:08:12 AM ECHO TLM
TX A Power 1.81 Watts
TX B Power 35.27 Watts
Torqr Cap V 998.48 V
Bat V 7.98 V
Cell 5 V 6.63 V
Cell 4 V 5.26 V
Cell 3 V 3.94 V
Cell 2 V 2.63 V
Cell 1 V 1.32 V
4.6V Exp I 422.21 mA
4.6V Exp V 4.61 V
3.3V I 28.64 mA
3.3V V 3.34 V
Total Array I 981.15 mA
Total Array V 11.94 V
+X I 9.98 mA
-X I 40.54 mA
+Y I 280.17 mA
-Y I 108.23 mA
+Z I 446.52 mA
-Z I 92.71 mA
+X V 12.27 V
-X V 2.18 V
+Y V 12.2 V
-Y V 3.33 V
+Z V 12.09 V
-Z V 8.28 V
Low V I 41 mA
Bat I 622.91 mA
Tx I .85 Amps
Bat sign 53 Counts
SQRX RSSI 4095 Counts
SQRX Spkr 4095 Counts
Torqr 1.2V ref 10.06V
Torqr Sense 4095 Counts
Not Used 2042 Counts
S Osc/Ext Temp -.98Deg C
TX B Temp -46.03 Deg C
Not Used 2047 Counts
S Driver Temp -2.24 Deg C
Temp +Z -7.19 Deg C
Not Used 2047 Counts
Temp +Y -2.83 Deg C
Temp -Y -5.08 Deg C
Temp +X -2.24 Deg C
Temp -X -5.02 Deg C
Bat 1 Temp 3.54 Deg C
Bat 2 Temp -2.07 Deg C
Main Reg Temp 4.16 Deg C
TX V Reg Temp 2.27 Deg C
Echo Solar Panel Telemetry
Solar Panels
+Z 12.1 V 446.5 mA -7.2 C
+X 12.3 V 10.0 mA -2.2 C
-Y 3.3 V 108.2 mA -5.1 C
-X 2.2 V 40.5 mA -5.0 C
+Y 12.2 V 280.2 mA -2.8 C
-Z 8.3 V 92.7 mA
Total Volts: 11.9
Total mA: 981.2
MMSSTV.EXE
Echo TX & RX Telemetry
UHF TX
TX A TX B
PWR (watts): 1.8 35.3
Enable: ON ON
PTT: ON OFF
Temp (C): -46.0
S Band TX
Exciter: OFF
Power Amp: OFF
Pwr Level: LOW
TX Current
Amps: 0.9
SQRX
RSSI: 4095
Spkr: 4095
Temp: -1.0
Power: OFF
Antenna: L/S
VHF RX
Power: ON
RX1 Channel: PRI
RX2 Channel: PRI
RX3 Channel: PRI
Echo Battery & BCR Telemetry
1 2 3 4 5 6
1.32 1.31 1.31 1.32 1.37 1.30
Volts: 1.32 2.63 3.94 5.26 6.63 7.93
Temp C: 03.5 -02.1
BATTERIES
Bat V 7.93
Bat mA 622.9
3.3 V 3.34
3.3 mA 28.6
BCR/Power System
4.6 V 4.61
4.6 mA 422.2
Start
Exploring - C:...
InstantTrack ...
tlmEcho
Echo Solar P...
Echo Battery ...
Echo TX &...
Echo TLM
untitled - Paint
11:11 PM

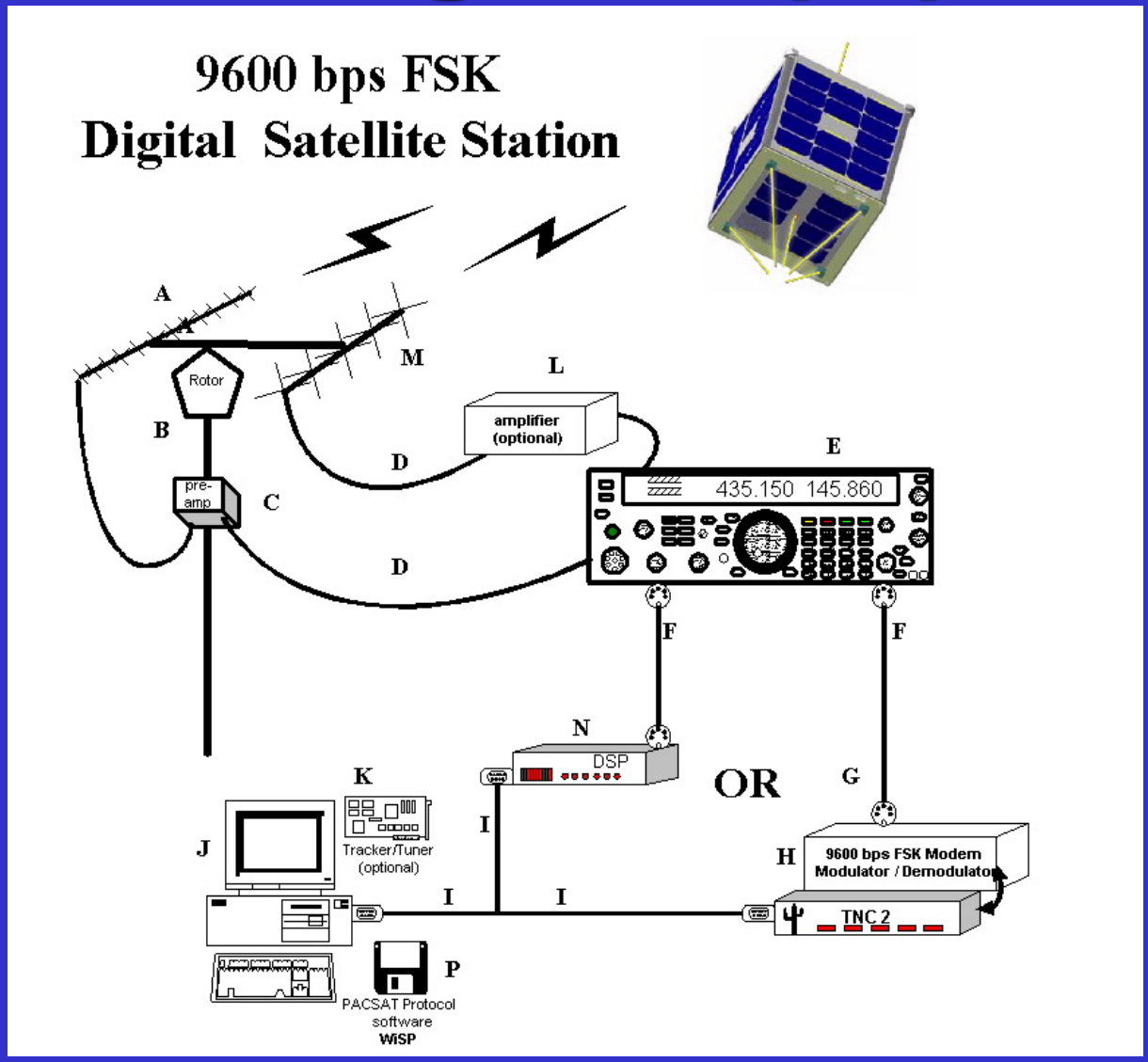
AO-51 Telemetry 7/7


Groundstation Control
Setup Housekeeping Tracking Database Programs
tlmEcho
File Setup TLM Help
Downlink
AO-51..WDOE & KE4AZN
PACB-1 > COMPB-1 :COMMAND G ACK adr path source 69 10 6
PACB-1 > COMPB-1 :COMMAND G ACK result 16
PACB-1 > LSTAT-0 :I P:0x4CA0 o:0 l:26135 f:29544, d:0 st:0 e:01
PACB-11 > PBLIST-0 :PB: Empty.
PACB-11 > PBLIST-0 :PB: Empty.
PACB-1 > TIME-1 :PHT: uptime is 004/12:53:02. Time is Wed Jul 07 16:22:26 2004
PACB-11 > PBLIST-0 :PB: Empty.
PACB-1 > TLMS-1 :C0:0D C1:44 C2:76 C3:27 C4:04
PACB-1 > LSTAT-0 :I P:0x4CA0 o:0 l:26135 f:29544, d:0 st:0 e:01
PACBLS-8 > PACBLS-8 :PACBLS S Meter = 55
PACB-1 > TIME-1 :PHT: uptime is 004/12:53:12. Time is Wed Jul 07 16:22:36 2004
PACB-1 > TLMI-1 :<binary tlm>
PACB-1 > LSTAT-0 :I P:0x4CA0 o:
PACB-11 > PBLIST-0 :PB: Empty.
Echo TX & RX Telemetry
UHF TX
TX A
TX B
PWR (watts): 1.4 35.3
Enable: ON ON
PTT: ON OFF
Temp (C): -46.0
S Band TX
Exciter: OFF
Power Amp: OFF
Pwr Level: LOW
TX Current
Amps: 0.8
SQRX
RSSI: 218.0
Spkr: 3874
Temp: 3.2
Power: ON
Antenna: L/S
VHF RX
Power: ON
RX1 Channel: PRI
RX2 Channel: PRI
RX3 Channel: PRI
Tracking Observer
ECHO 16:24:08 7 Jul
Lat:20.965N Lon: 89.836W Hght:
Next LOS 00:02:48
Observer Azm
WA4SXM 201
Echo Battery & BCR Telemetry
1 2 3 4 5 6
1.51 1.50 1.50 1.52 1.57 1.44
Volts: 1.51 3.01 4.51 6.03 7.60 9.04
Temp C: 04.3 04.6
BATTERIES
Bat V 9.04
Bat mA 434.2
BCR/Power System
Main V reg Temp 16.4
TX V reg Temp 10.6
Solar V 15.1
Solar mA 932.9
from Solar System
3.3 V 3.34
3.3 mA 49.6
4.6 V 4.60
4.6 mA 247.4
Low Volt
mA 97.0
+4V #1 4.03 V
+4V #2 4.03 V
Solar Panels
+Z 15.3 V 152.9 mA 9.7 C
+X 15.6 V 462.6 mA 5.7 C
-Y 15.4 V 70.7 mA 6.5 C
-X 15.5 V 5.9 mA 6.5 C
+Y 15.5 V 60.7 mA 4.8 C
-Z 15.5 V 358.5 mA
Total Volts: 15.1
Total mA: 932.9
To BCR System
Start
Exploring - C:\E...
Groundstation C...
Groundstation C...
tlmEcho
Echo TX & R...
Echo Solar Pane...
Echo Battery & B...
12:24 PM

AO-51 I/O Registers



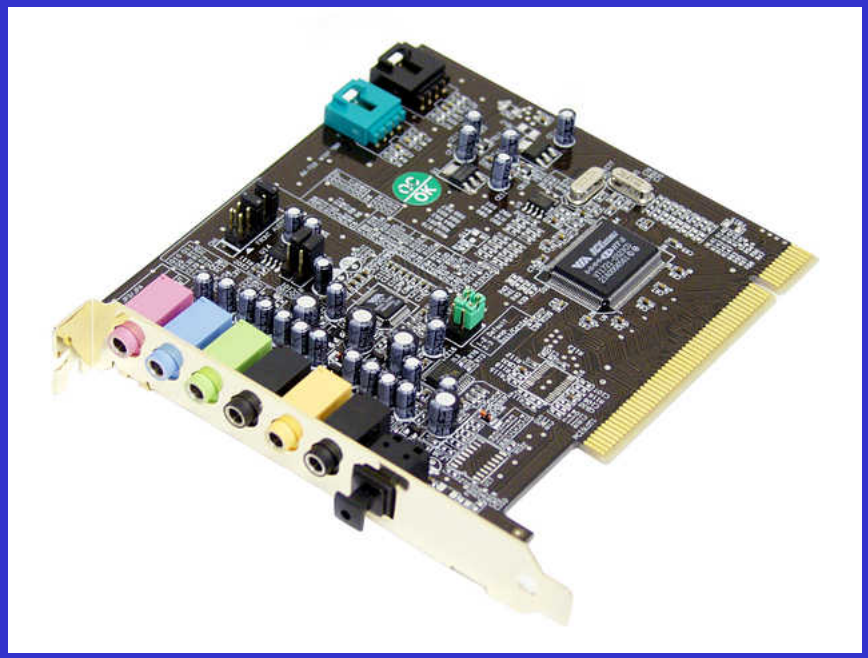
AO-51 Digital Equipment



Problem with hardware demodulation

- Very few suppliers of modems
- Expensive
- Limited number of digital satellites with which to use them

Alternative 9600 bps Digital Demodulation



Problem with software demodulation

- Getting the demodulated data to the AO-51 telemetry decoding program
- Having enough horsepower in the computer to perform multiple tasks
- Having enough serial ports
- Understanding how to physically/virtually connect these devices

AO-51 Need!

- Sound card 9600 bps demodulator tied to tlmECHO software

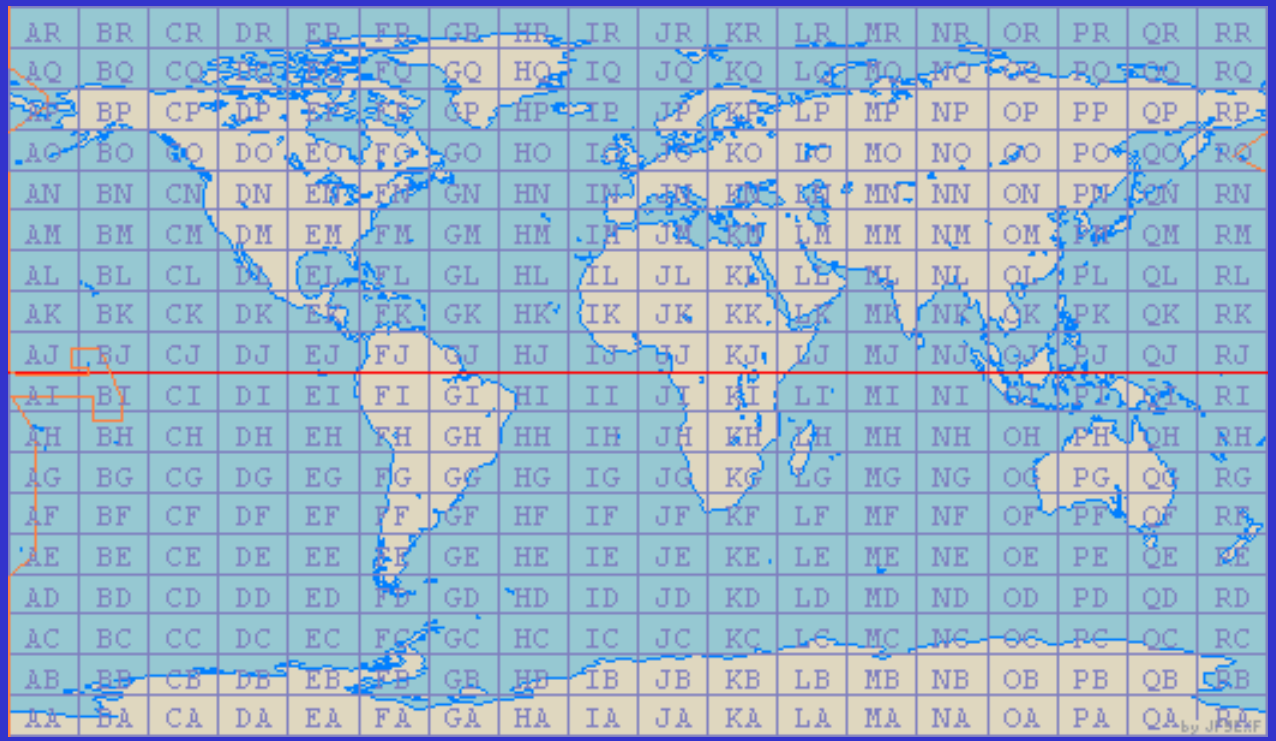
OR

- New program to demodulate, display and log the telemetry data

AO-51 Analog Operations

- FM voice repeater mode
- Opened for general use 30 July 2004
- Works extremely well with 1 Watt out
- AO-51 is everything it was expected to be, great demonstration and entry satellite

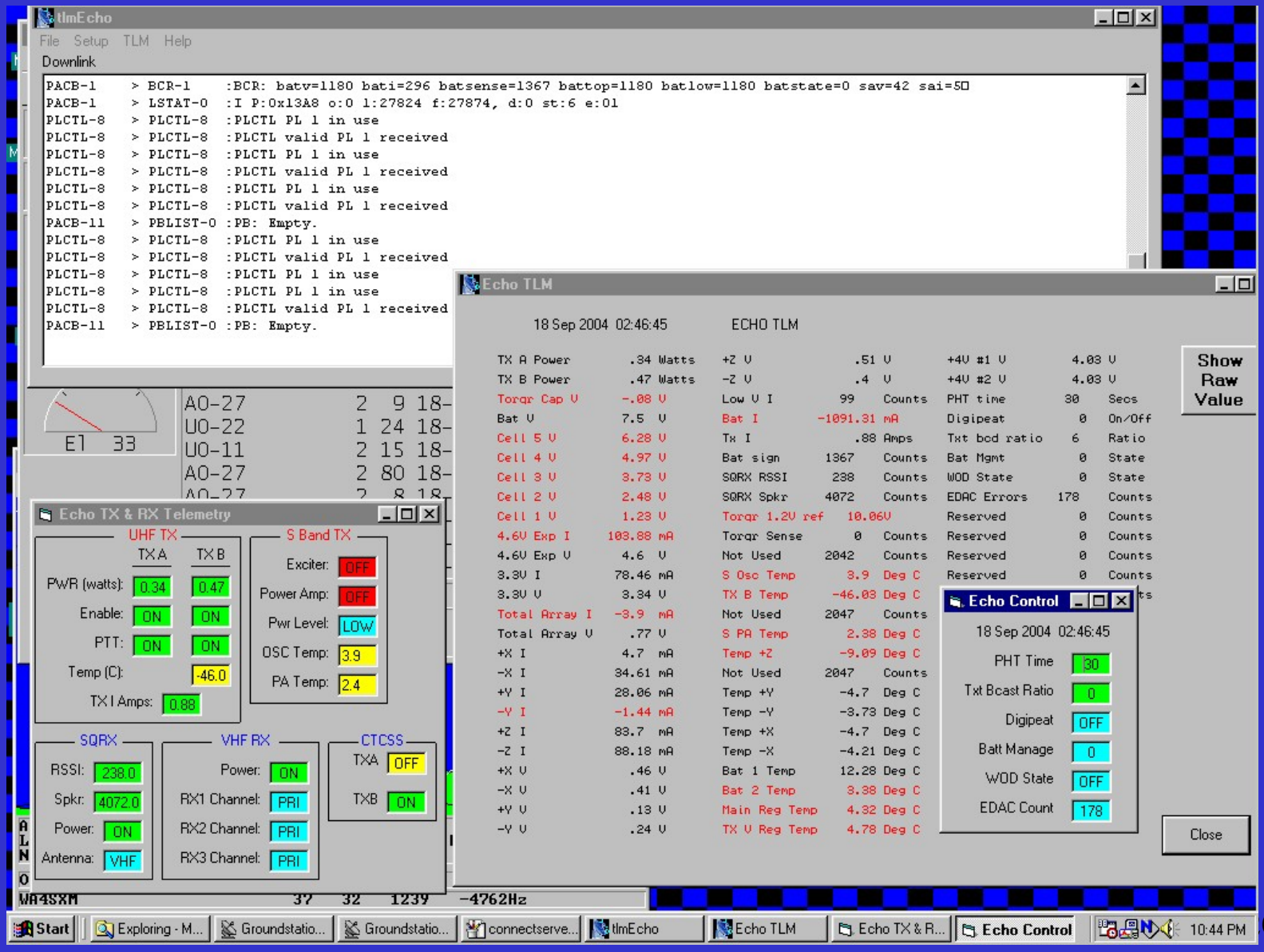
AO-51 Operators Chasing Grid Squares



Let the logging begin!

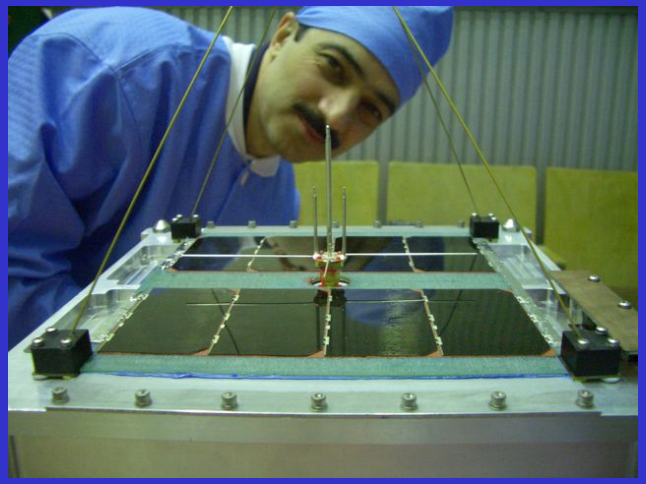
AO-51 LEO Outside Hardware

AO-51 PL tones

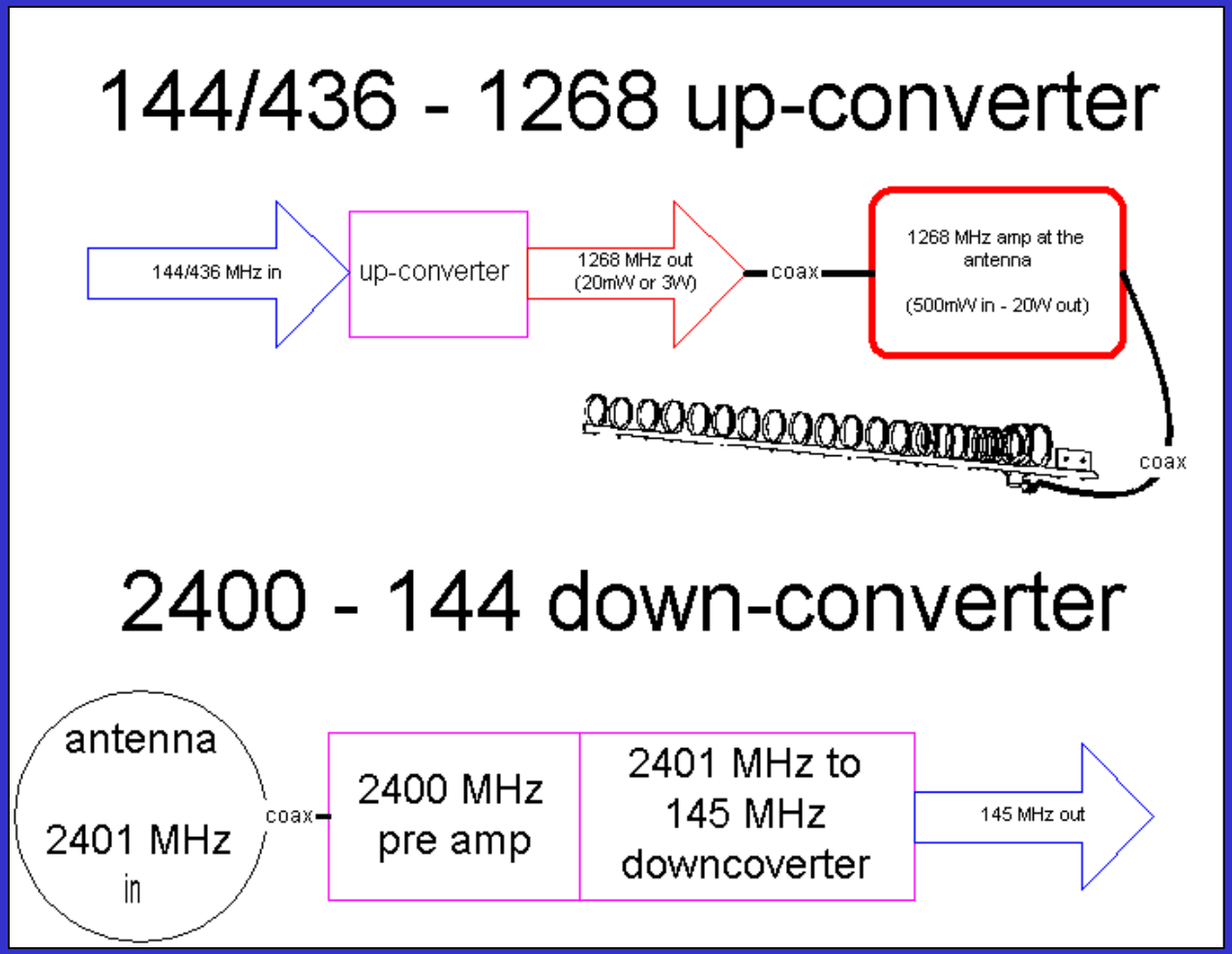


AO-51 Experimenter's Day
[Now let the fun begin]

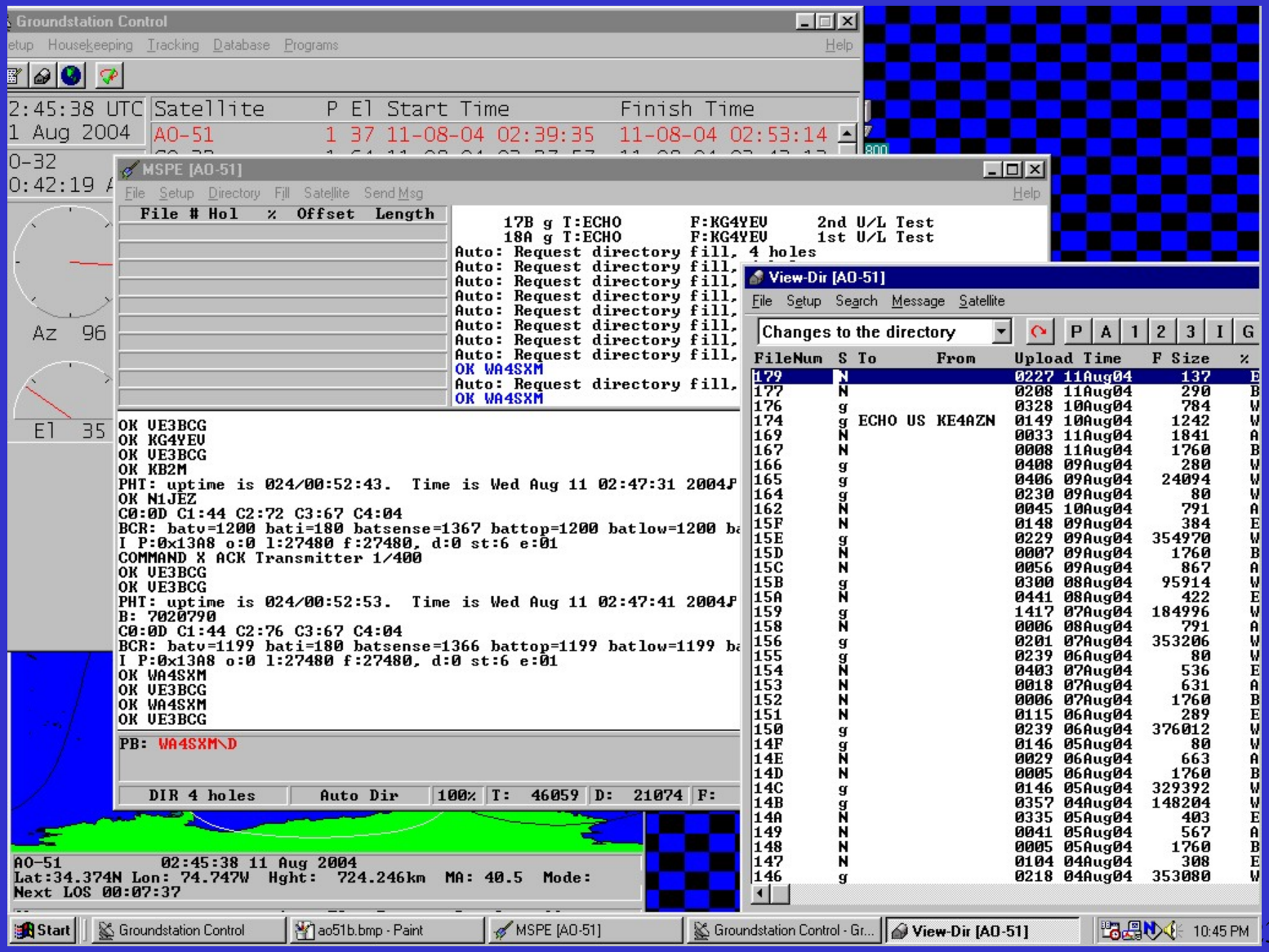
- **4 AUG 04** First Experimenter's Wednesday
  - FM repeater
  - Mode L/U (1268.70 MHz uplink)
- **11 AUG 04** 2nd Experimenter's Wednesday
  - 9k6 Pacsat Broadcast Protocol BB
  - Mode V/U FM
- **25 AUG 04** 3rd Experimenter's Wednesday
  - FM repeater
  - Mode V/S (2401.200 MHz downlink)



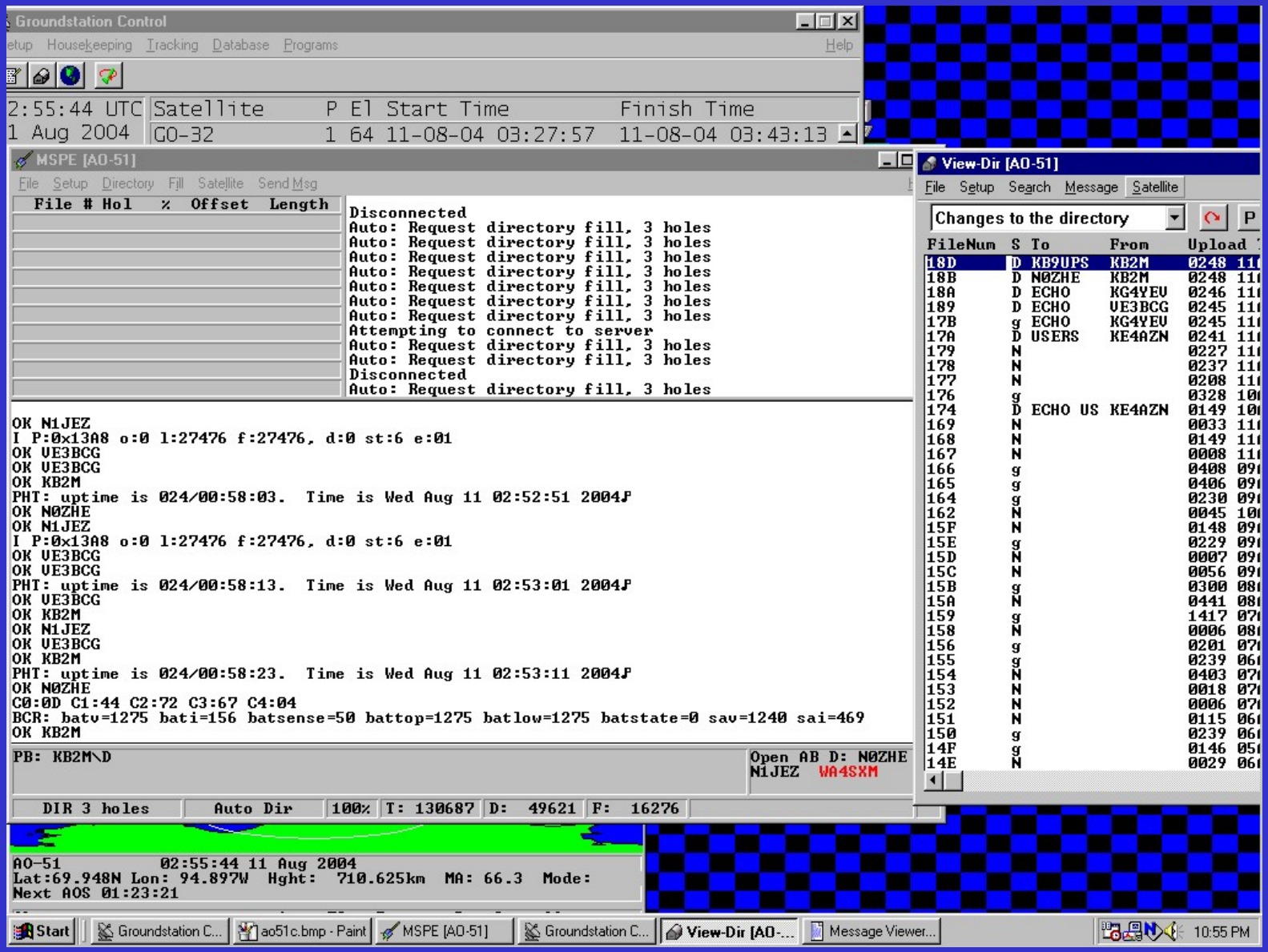
AO-51 GHz Hardware



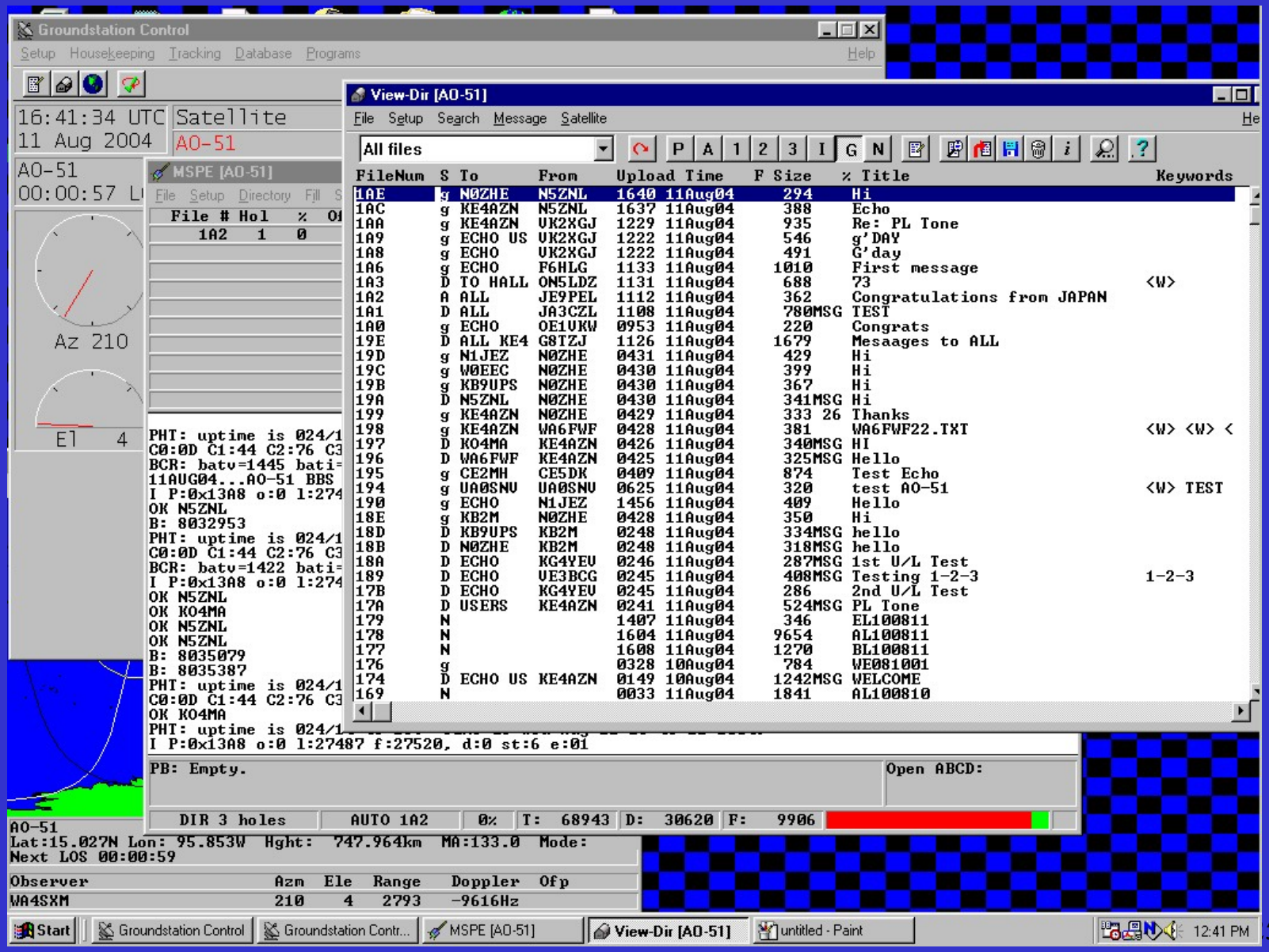
AO-51 BB 8/11/04


Groundstation Control
Setup Housekeeping Tracking Database Programs Help
2:45:38 UTC
1 Aug 2004
Satellite P El Start Time Finish Time
AO-51 1 37 11-08-04 02:39:35 11-08-04 02:53:14
0-32
0:42:19
Az 96
El 35
MSPE [AO-51]
File Setup Directory Fill Satellite Send Msg Help
File # Hol % Offset Length
17B g T:ECHO F:KG4YEU 2nd U/L Test
18A g T:ECHO F:KG4YEU 1st U/L Test
Auto: Request directory fill, 4 holes
Auto: Request directory fill,
Auto: Request directory fill,
Auto: Request directory fill,
Auto: Request directory fill,
Auto: Request directory fill,
Auto: Request directory fill,
Auto: Request directory fill,
OK WA4SXM
Auto: Request directory fill,
OK WA4SXM
OK VE3BCG
OK KG4YEU
OK VE3BCG
OK KB2M
PHT: uptime is 024/00:52:43. Time is Wed Aug 11 02:47:31 2004
OK N1JEZ
C0:0D C1:44 C2:72 C3:67 C4:04
BCR: batv=1200 bati=180 batsense=1367 battop=1200 batlow=1200 ba
I P:0x13A8 o:0 l:27480 f:27480, d:0 st:6 e:01
COMMAND X ACK Transmitter 1/400
OK VE3BCG
OK VE3BCG
PHT: uptime is 024/00:52:53. Time is Wed Aug 11 02:47:41 2004
B: 7020790
C0:0D C1:44 C2:76 C3:67 C4:04
BCR: batv=1199 bati=180 batsense=1366 battop=1199 batlow=1199 ba
I P:0x13A8 o:0 l:27480 f:27480, d:0 st:6 e:01
OK WA4SXM
OK VE3BCG
OK WA4SXM
OK VE3BCG
PB: WA4SXM\D
DIR 4 holes Auto Dir 100% T: 46059 D: 21074 F:
View-Dir [AO-51]
File Setup Search Message Satellite
Changes to the directory
P A 1 2 3 I G
FileNum S To From Upload Time F Size %
179 N 0227 11Aug04 137 E
177 N 0208 11Aug04 290 B
176 g 0328 10Aug04 784 W
174 g ECHO US KE4AZN 0149 10Aug04 1242 W
169 N 0033 11Aug04 1841 A
167 N 0008 11Aug04 1760 B
166 g 0408 09Aug04 280 W
165 g 0406 09Aug04 24094 W
164 g 0230 09Aug04 80 W
162 N 0045 10Aug04 791 A
15F N 0148 09Aug04 384 E
15E g 0229 09Aug04 354970 W
15D N 0007 09Aug04 1760 B
15C N 0056 09Aug04 867 A
15B g 0300 08Aug04 95914 W
15A N 0441 08Aug04 422 E
159 g 1417 07Aug04 184996 W
158 N 0006 08Aug04 791 A
156 g 0201 07Aug04 353206 W
155 g 0239 06Aug04 80 W
154 N 0403 07Aug04 536 E
153 N 0018 07Aug04 631 A
152 N 0006 07Aug04 1760 B
151 N 0115 06Aug04 289 E
150 g 0239 06Aug04 376012 W
14F g 0146 05Aug04 80 W
14E N 0029 06Aug04 663 A
14D N 0005 06Aug04 1760 B
14C g 0146 05Aug04 329392 W
14B g 0357 04Aug04 148204 W
14A N 0335 05Aug04 403 E
149 N 0041 05Aug04 567 A
148 N 0005 05Aug04 1760 B
147 N 0104 04Aug04 308 E
146 g 0218 04Aug04 353080 W
AO-51 02:45:38 11 Aug 2004
Lat:34.374N Lon: 74.747W Hght: 724.246km MA: 40.5 Mode:
Next LOS 00:07:37
Start
Groundstation Control
ao51b.bmp - Paint
MSPE [AO-51]
Groundstation Control - Gr...
View-Dir [AO-51]
10:45 PM

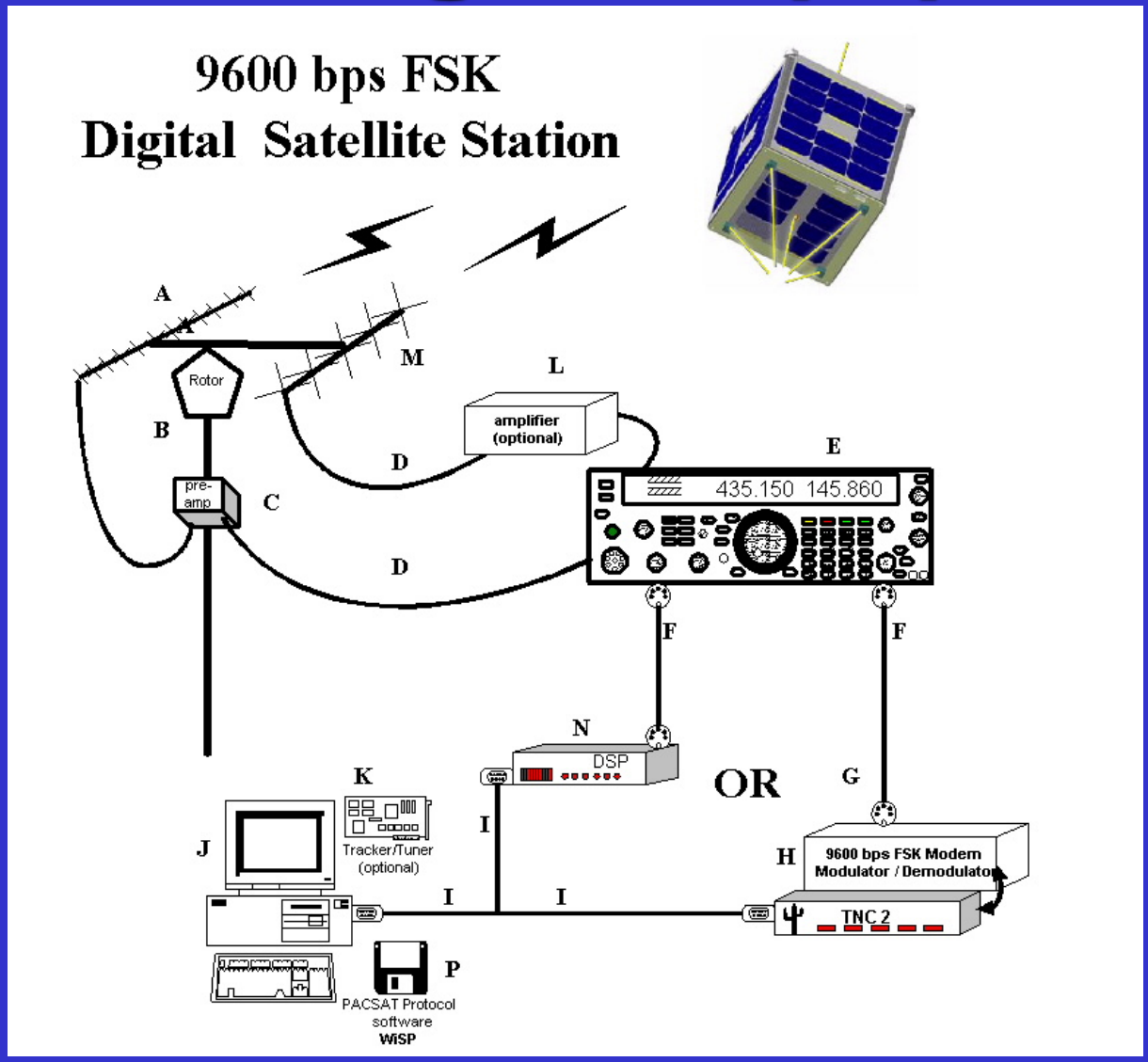
AO-51 BB First Files


Groundstation Control
Setup Housekeeping Tracking Database Programs Help
2:55:44 UTC
1 Aug 2004
Satellite P El Start Time Finish Time
GO-32 1 64 11-08-04 03:27:57 11-08-04 03:43:13
MSPE [AO-51]
File Setup Directory Fill Satellite Send Msg
File # Hol % Offset Length
Disconnected
Auto: Request directory fill, 3 holes
Auto: Request directory fill, 3 holes
Auto: Request directory fill, 3 holes
Auto: Request directory fill, 3 holes
Auto: Request directory fill, 3 holes
Auto: Request directory fill, 3 holes
Auto: Request directory fill, 3 holes
Attempting to connect to server
Auto: Request directory fill, 3 holes
Auto: Request directory fill, 3 holes
Disconnected
Auto: Request directory fill, 3 holes
OK N1JEZ
I P:0x13A8 o:0 l:27476 f:27476, d:0 st:6 e:01
OK VE3BCG
OK VE3BCG
OK KB2M
PHT: uptime is 024/00:58:03. Time is Wed Aug 11 02:52:51 2004
OK N0ZHE
OK N1JEZ
I P:0x13A8 o:0 l:27476 f:27476, d:0 st:6 e:01
OK VE3BCG
OK VE3BCG
PHT: uptime is 024/00:58:13. Time is Wed Aug 11 02:53:01 2004
OK VE3BCG
OK KB2M
OK N1JEZ
OK VE3BCG
OK KB2M
PHT: uptime is 024/00:58:23. Time is Wed Aug 11 02:53:11 2004
OK N0ZHE
C0:0D C1:44 C2:72 C3:67 C4:04
BCR: batv=1275 bati=156 batsense=50 battop=1275 batlow=1275 batstate=0 sav=1240 sai=469
OK KB2M
PB: KB2M\D
Open AB D: N0ZHE
N1JEZ WA4SXM
DIR 3 holes Auto Dir 100% T: 130687 D: 49621 F: 16276
View-Dir [AO-51]
File Setup Search Message Satellite
Changes to the directory
FileNum S To From Upload
18D D KB9UPS KB2M 0248 11
18B D N0ZHE KB2M 0248 11
18A D ECHO KG4YEU 0246 11
189 D ECHO VE3BCG 0245 11
17B g ECHO KG4YEU 0245 11
17A D USERS KE4AZN 0241 11
179 N 0227 11
178 N 0237 11
177 N 0208 11
176 g 0328 10
174 D ECHO US KE4AZN 0149 10
169 N 0033 11
168 N 0149 11
167 N 0008 11
166 g 0408 09
165 g 0406 09
164 g 0230 09
162 N 0045 10
15F N 0148 09
15E g 0229 09
15D N 0007 09
15C N 0056 09
15B g 0300 08
15A N 0441 08
159 g 1417 07
158 N 0006 08
156 g 0201 07
155 g 0239 06
154 N 0403 07
153 N 0018 07
152 N 0006 07
151 N 0115 06
150 g 0239 06
14F g 0146 05
14E N 0029 06
AO-51 02:55:44 11 Aug 2004
Lat:69.948N Lon: 94.897W Hght: 710.625km MA: 66.3 Mode:
Next AOS 01:23:21
Start
Groundstation C...
ao51c.bmp - Paint
MSPE [AO-51]
Groundstation C...
View-Dir [AO-...
Message Viewer...
10:55 PM

AO-51 BB First Files

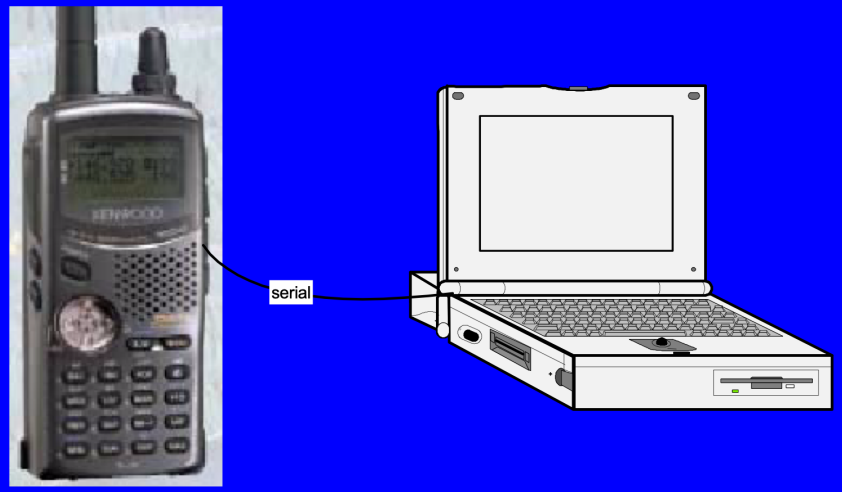

Groundstation Control
Setup Housekeeping Tracking Database Programs Help
16:41:34 UTC
11 Aug 2004
Satellite
AO-51
AO-51
00:00:57
Az 210
El 4
MSPE [AO-51]
File Setup Directory Fill
File # Hol % Of
1A2 1 0
View-Dir [AO-51]
File Setup Search Message Satellite
All files
P A 1 2 3 I G N
FileNum S To From Upload Time F Size % Title Keywords
1AE g N0ZHE N5ZNL 1640 11Aug04 294 Hi
1AC g KE4AZN N5ZNL 1637 11Aug04 388 Echo
1AA g KE4AZN VK2XGJ 1229 11Aug04 935 Re: PL Tone
1A9 g ECHO US VK2XGJ 1222 11Aug04 546 g'DAY
1A8 g ECHO VK2XGJ 1222 11Aug04 491 G'day
1A6 g ECHO F6HLG 1133 11Aug04 1010 First message
1A3 D TO HALL ON5LDZ 1131 11Aug04 688 73 <W>
1A2 A ALL JE9PEL 1112 11Aug04 362 Congratulations from JAPAN
1A1 D ALL JA3CZL 1108 11Aug04 780MSG TEST
1A0 g ECHO OE1VKW 0953 11Aug04 220 Congrats
19E D ALL KE4 G8TZJ 1126 11Aug04 1679 Mesaages to ALL
19D g N1JEZ N0ZHE 0431 11Aug04 429 Hi
19C g W0EEC N0ZHE 0430 11Aug04 399 Hi
19B g KB9UPS N0ZHE 0430 11Aug04 367 Hi
19A D N5ZNL N0ZHE 0430 11Aug04 341MSG Hi
199 g KE4AZN N0ZHE 0429 11Aug04 333 26 Thanks
198 g KE4AZN WA6FWF 0428 11Aug04 381 WA6FWF22.TXT <W> <W> <
197 D KO4MA KE4AZN 0426 11Aug04 340MSG HI
196 D WA6FWF KE4AZN 0425 11Aug04 325MSG Hello
195 g CE2MH CE5DK 0409 11Aug04 874 Test Echo
194 g UA0SNV UA0SNV 0625 11Aug04 320 test AO-51 <W> TEST
190 g ECHO N1JEZ 1456 11Aug04 409 Hello
18E g KB2M N0ZHE 0428 11Aug04 350 Hi
18D D KB9UPS KB2M 0248 11Aug04 334MSG hello
18B D N0ZHE KB2M 0248 11Aug04 318MSG hello
18A D ECHO KG4YEU 0246 11Aug04 287MSG 1st U/L Test
189 D ECHO VE3BCG 0245 11Aug04 408MSG Testing 1-2-3 1-2-3
17B D ECHO KG4YEU 0245 11Aug04 286 2nd U/L Test
17A D USERS KE4AZN 0241 11Aug04 524MSG PL Tone
179 N 1407 11Aug04 346 EL100811
178 N 1604 11Aug04 9654 AL100811
177 N 1608 11Aug04 1270 BL100811
176 g 0328 10Aug04 784 WE081001
174 D ECHO US KE4AZN 0149 10Aug04 1242MSG WELCOME
169 N 0033 11Aug04 1841 AL100810
PHT: uptime is 024/1
C0:0D C1:44 C2:76 C3
BCR: batv=1445 bati=
11AUG04...AO-51 BBS
I P:0x13A8 o:0 1:274
OK N5ZNL
B: 8032953
PHT: uptime is 024/1
C0:0D C1:44 C2:76 C3
BCR: batv=1422 bati=
I P:0x13A8 o:0 1:274
OK N5ZNL
OK KO4MA
OK N5ZNL
OK N5ZNL
B: 8035079
B: 8035387
PHT: uptime is 024/1
C0:0D C1:44 C2:76 C3
OK KO4MA
PHT: uptime is 024/1
I P:0x13A8 o:0 1:27487 f:27520, d:0 st:6 e:01
PB: Empty.
Open ABCD:
DIR 3 holes
AUTO 1A2
0%
T: 68943
D: 30620
F: 9906
AO-51
Lat:15.027N Lon: 95.853W Hght: 747.964km MA:133.0 Mode:
Next LOS 00:00:59
Observer Azm Ele Range Doppler Ofp
WA4SXM 210 4 2793 -9616Hz
Start
Groundstation Control
Groundstation Contr...
MSPE [AO-51]
View-Dir [AO-51]
untitled - Paint
12:41 PM

AO-51 Digital Equipment



AO-51 Digital Test Equipment

9600 bps test station

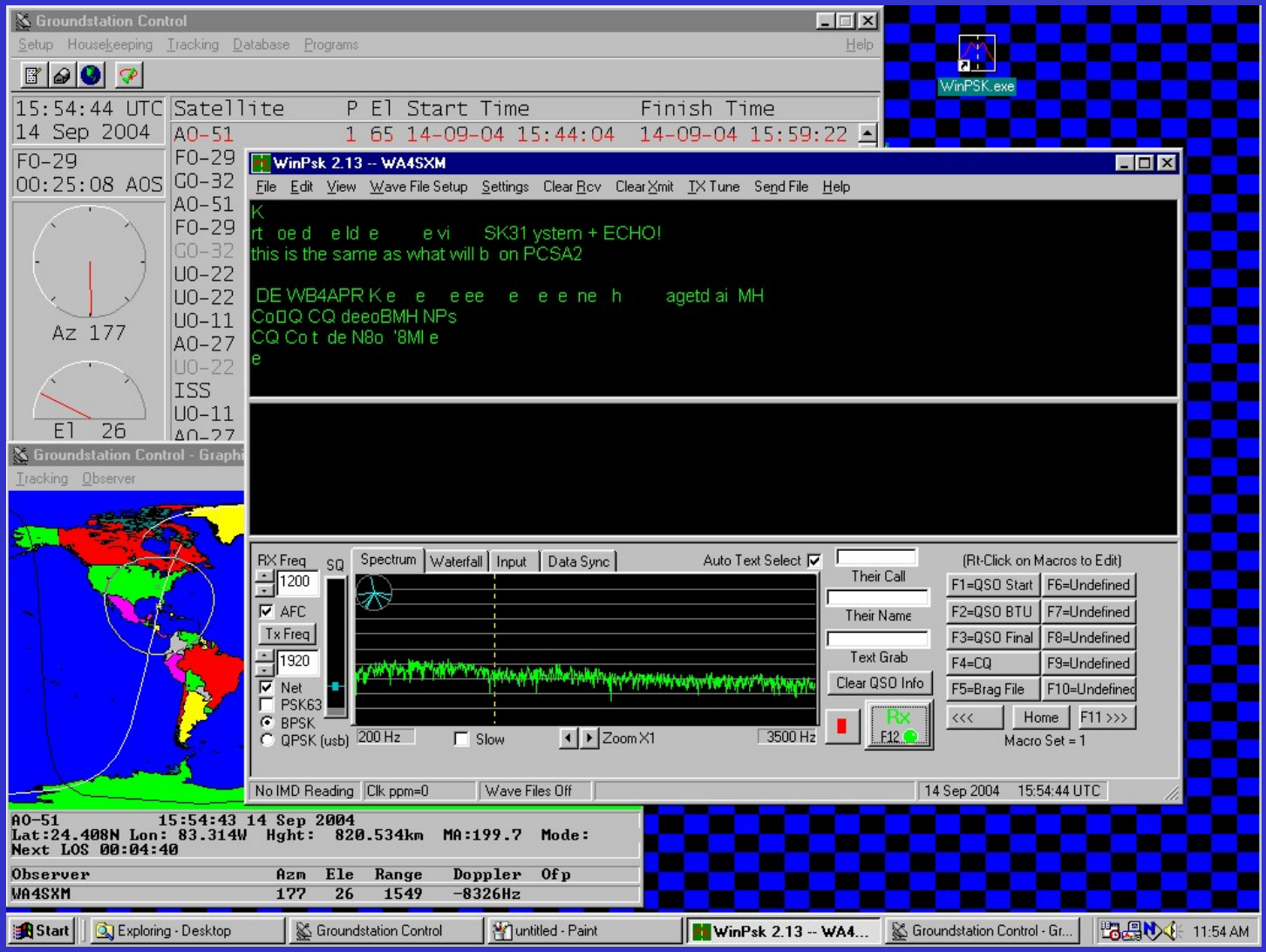


THD-7A and a laptop

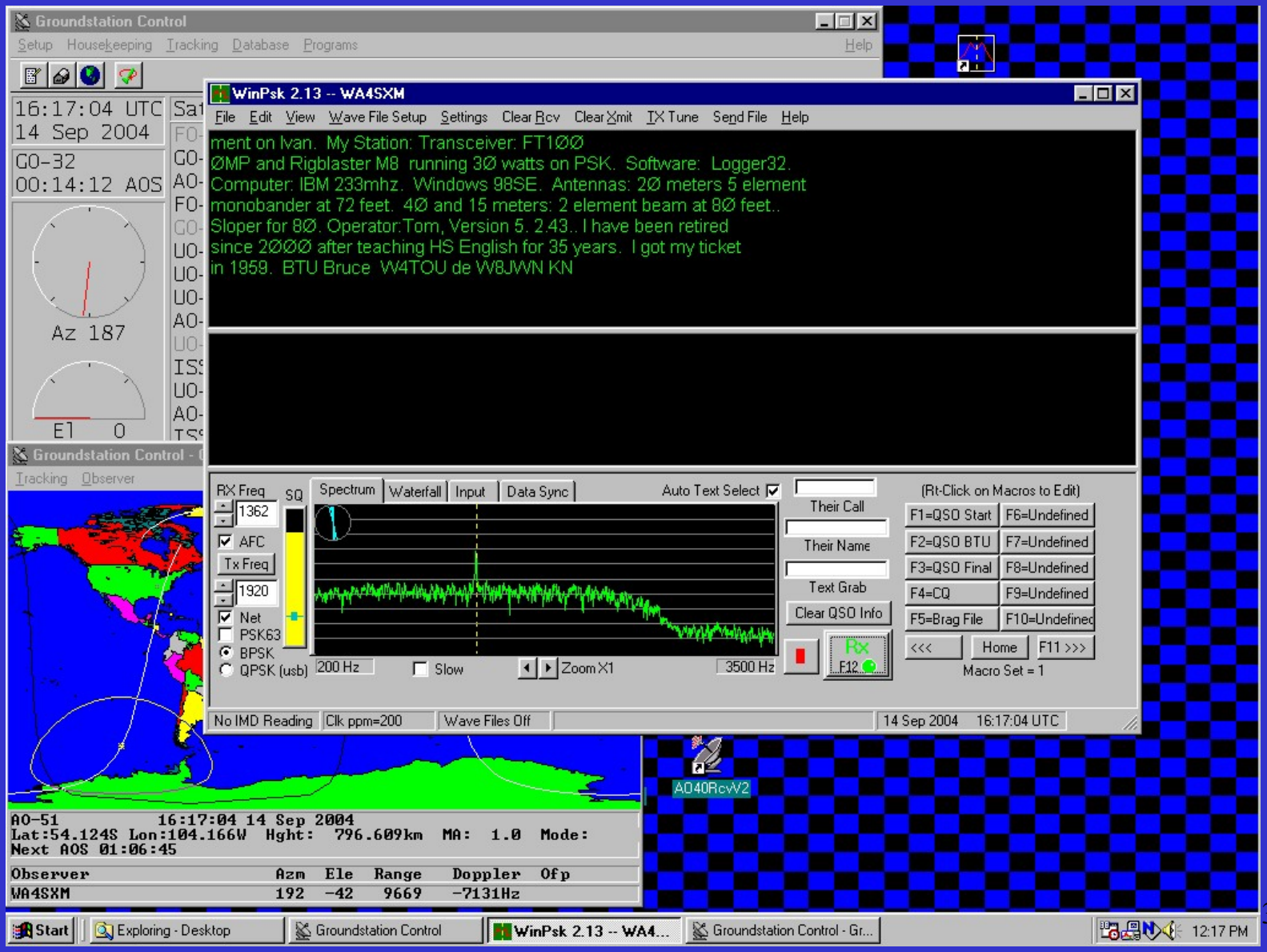
AO-51 Experimenter's Day

- **1 SEP 04**
  - FM repeater
  - Mode L/S (1.268.70 GHz ↑, 2.4 GHz↓)
- **11 SEP 04**
  - 38k4 Telemetry downlink
  - Mode /US FM
- **14 SEP 04**
  - PSK31 test
  - Mode H/U (10M SSB ↑, 70cm ↓)
- **15 SEP 04**
  - 38k4 BB (38400 bps ↓, 9600 bps ↑)
  - Mode V/U FM

AO-51 PSK31


Groundstation Control
Setup Housekeeping Tracking Database Programs Help
15:54:44 UTC
14 Sep 2004
Satellite P El Start Time Finish Time
AO-51 1 65 14-09-04 15:44:04 14-09-04 15:59:22
FO-29
00:25:08 AOS
Az 177
El 26
FO-29
GO-32
AO-51
FO-29
GO-32
UO-22
UO-22
UO-11
AO-27
UO-22
ISS
UO-11
WinPSK.exe
WinPsk 2.13 -- WA4SXM
File Edit View Wave File Setup Settings Clear Rcv Clear Xmit TX Tune Send File Help
this is the same as what will b on PCSA2
DE WB4APR K
CQ CQ
Groundstation Control - Graphi
Tracking Observer
RX Freq
1200
AFC
Tx Freq
1920
Net
PSK63
BPSK
QPSK (usb)
SQ
Spectrum Waterfall Input Data Sync
Auto Text Select
200 Hz
Slow
Zoom X1
3500 Hz
Their Call
Their Name
Text Grab
Clear QSO Info
Rx
F12
(Rt-Click on Macros to Edit)
F1=QSO Start
F2=QSO BTU
F3=QSO Final
F4=CQ
F5=Brag File
F6=Undefined
F7=Undefined
F8=Undefined
F9=Undefined
F10=Undefined
<<<
Home
F11 >>>
Macro Set = 1
No IMD Reading
Clk ppm=0
Wave Files Off
14 Sep 2004 15:54:44 UTC
AO-51 15:54:43 14 Sep 2004
Lat:24.408N Lon: 83.314W Hght: 820.534km MA:199.7 Mode:
Next LOS 00:04:40
Observer Azm Ele Range Doppler Ofp
WA4SXM 177 26 1549 -8326Hz
Start
Exploring - Desktop
Groundstation Control
untitled - Paint
WinPsk 2.13 -- WA4...
Groundstation Control - Gr...
11:54 AM

AO-51 PSK31


Groundstation Control
Setup Housekeeping Tracking Database Programs Help
WinPsk 2.13 -- WA4SXM
File Edit View Wave File Setup Settings Clear Rcv Clear Xmit TX Tune Send File Help
ment on Ivan. My Station: Transceiver: FT1ØØ
ØMP and Rigblaster M8 running 3Ø watts on PSK. Software: Logger32.
Computer: IBM 233mhz. Windows 98SE. Antennas: 2Ø meters 5 element
monobander at 72 feet. 4Ø and 15 meters: 2 element beam at 8Ø feet..
Sloper for 8Ø. Operator:Tom, Version 5. 2.43.. I have been retired
since 2ØØØ after teaching HS English for 35 years. I got my ticket
in 1959. BTU Bruce W4TOU de W8JWN KN
16:17:04 UTC
14 Sep 2004
GO-32
00:14:12 AOS
Az 187
El 0
Groundstation Control - (
Tracking Observer
RX Freq
1362
AFC
Tx Freq
1920
Net
PSK63
BPSK
QPSK (usb)
SQ
Spectrum Waterfall Input Data Sync
Auto Text Select
200 Hz
Slow
Zoom X1
3500 Hz
Their Call
Their Name
Text Grab
Clear QSO Info
RX F12
(Rt-Click on Macros to Edit)
F1=QSO Start F6=Undefined
F2=QSO BTU F7=Undefined
F3=QSO Final F8=Undefined
F4=CQ F9=Undefined
F5=Brag File F10=Undefined
<<< Home F11 >>>
Macro Set = 1
No IMD Reading Clk ppm=200 Wave Files Off
14 Sep 2004 16:17:04 UTC
AO40RcvV2
AO-51 16:17:04 14 Sep 2004
Lat:54.124S Lon:104.166W Hght: 796.609km MA: 1.0 Mode:
Next AOS 01:06:45
Observer Azm Ele Range Doppler Ofp
WA4SXM 192 -42 9669 -7131Hz
Start
Exploring - Desktop
Groundstation Control
WinPsk 2.13 -- WA4...
Groundstation Control - Gr...
12:17 PM

AO-51 Experimenter's Day

- **22 SEP 04**
  - 38k4 BBS (38400 bps ↓, 9600 bps ↑)
  - Mode V/U FM
- **29 SEP 04**
  - PSK31 test
  - Mode H/U (10M SSB ↑, 70cm ↓)
- **6 OCT 04**
  - 38k4 BBS (38400 bps ↓, 9600 bps ↑)
  - Mode V/U FM
- **20 SEP 04**
  - FM repeater
  - Mode L/U (1.268.70 GHz ↑, 70 cm ↓)

38k4 BBS on AO-51

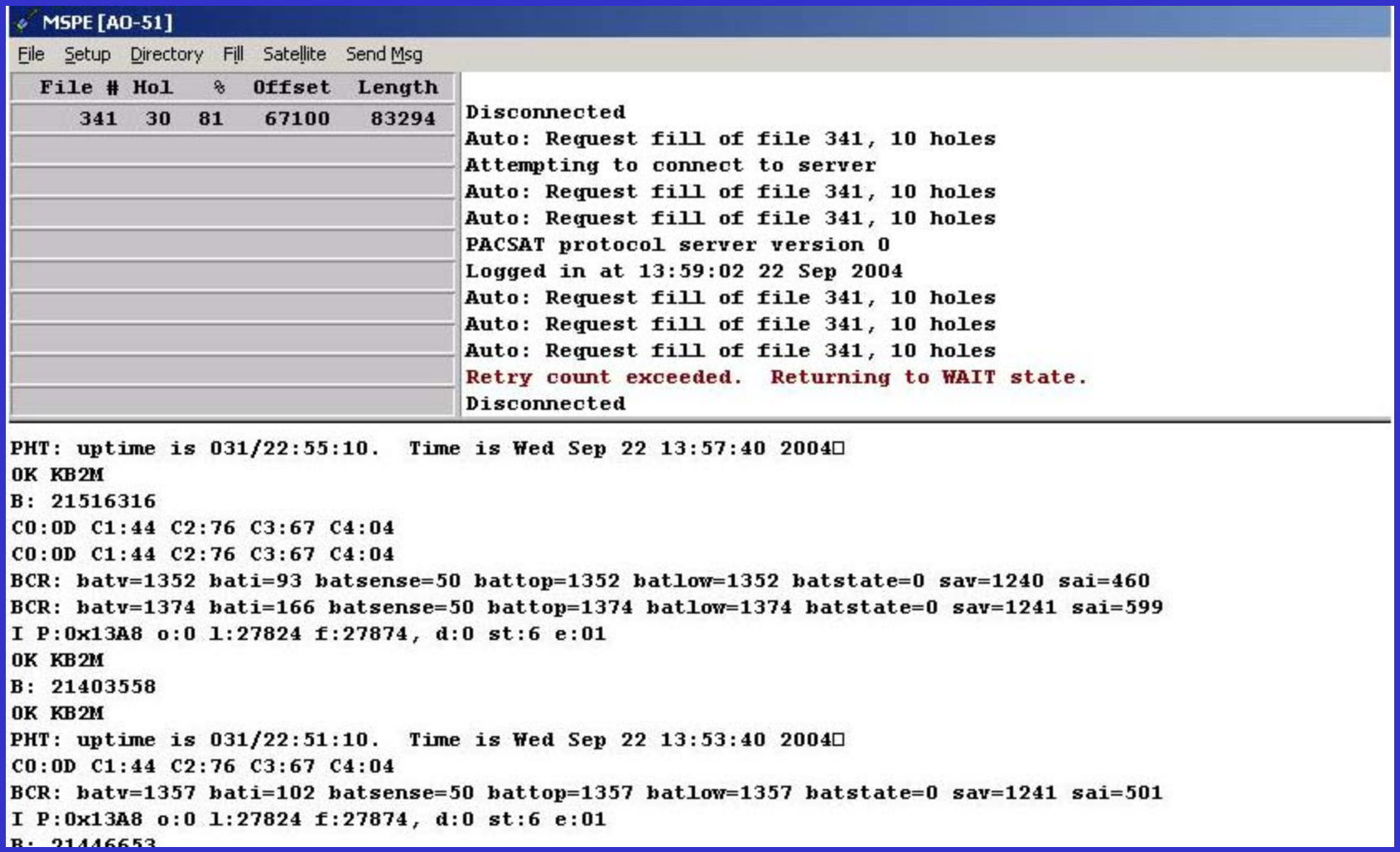
```
C0:0D C1:44 C2:76 C3:67 C4:04
BCR: batv=1357 bati=102 batsense=50 battop=1357 batlow=1357 batstate=0 sav=1241 sai=501
I P:0x13A8 o:0 l:27824 f:27874, d:0 st:6 e:01
B: 21446653
PHT: uptime is 031/22:51:40.  Time is Wed Sep 22 13:54:10 2004□
C0:0D C1:44 C2:76 C3:67 C4:04
BCR: batv=1349 bati=64 batsense=50 battop=1349 batlow=1349 batstate=0 sav=1240 sai=449
20SEP04...See Amsat.org for Schedule...AO-51 9K6 BBS OPEN (145.860/435.150)...FM repeat mode OPEN (
I P:0x13A8 o:0 l:27824 f:27874, d:0 st:6 e:01
B: 21491990
PHT: uptime is 031/22:52:10.  Time is Wed Sep 22 13:54:40 2004□
PHT: uptime is 031/22:52:40.  Time is Wed Sep 22 13:55:10 2004□
OK KB2M
PHT: uptime is 031/22:53:10.  Time is Wed Sep 22 13:55:40 2004□
B: 21503056
OK KB2M
C0:0D C1:44 C2:76 C3:67 C4:04
BCR: batv=1366 bati=159 batsense=50 battop=1366 batlow=1366 batstate=0 sav=1241 sai=553
I P:0x13A8 o:0 l:27824 f:27855, d:0 st:6 e:01
OK KB2M
B: 21511981
I P:0x13A8 o:0 l:27824 f:27855, d:0 st:6 e:01
B: 21511981
PHT: uptime is 031/22:55:10.  Time is Wed Sep 22 13:57:40 2004□
OK KB2M
B: 21516316
C0:0D C1:44 C2:76 C3:67 C4:04
C0:0D C1:44 C2:76 C3:67 C4:04
BCR: batv=1352 bati=93 batsense=50 battop=1352 batlow=1352 batstate=0 sav=1240 sai=460

PB: Empty.

DIR <Up to Date>   AUTO 341   23%   T:  81636   D:    320   F:  67678
```

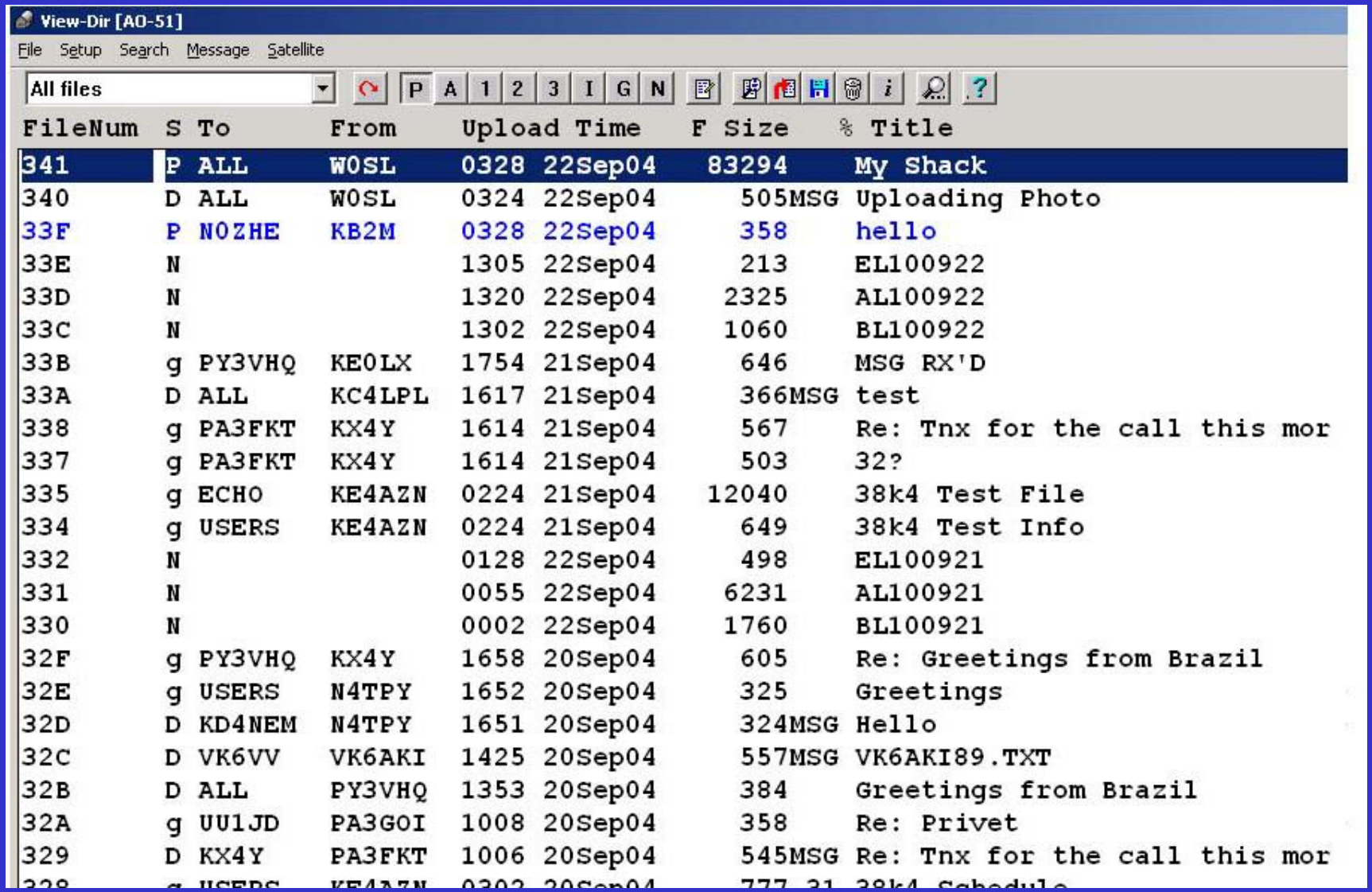
Data from KB2M

38k4 BBS on AO-51


MSPE [AO-51]
File Setup Directory Fill Satellite Send Msg
File # Hol % Offset Length
341 30 81 67100 83294
Disconnected
Auto: Request fill of file 341, 10 holes
Attempting to connect to server
Auto: Request fill of file 341, 10 holes
Auto: Request fill of file 341, 10 holes
PACSAT protocol server version 0
Logged in at 13:59:02 22 Sep 2004
Auto: Request fill of file 341, 10 holes
Auto: Request fill of file 341, 10 holes
Auto: Request fill of file 341, 10 holes
Retry count exceeded. Returning to WAIT state.
Disconnected
PHT: uptime is 031/22:55:10. Time is Wed Sep 22 13:57:40 2004
OK KB2M
B: 21516316
C0:0D C1:44 C2:76 C3:67 C4:04
C0:0D C1:44 C2:76 C3:67 C4:04
BCR: batv=1352 bati=93 batsense=50 battop=1352 batlow=1352 batstate=0 sav=1240 sai=460
BCR: batv=1374 bati=166 batsense=50 battop=1374 batlow=1374 batstate=0 sav=1241 sai=599
I P:0x13A8 o:0 1:27824 f:27874, d:0 st:6 e:01
OK KB2M
B: 21403558
OK KB2M
PHT: uptime is 031/22:51:10. Time is Wed Sep 22 13:53:40 2004
C0:0D C1:44 C2:76 C3:67 C4:04
BCR: batv=1357 bati=102 batsense=50 battop=1357 batlow=1357 batstate=0 sav=1241 sai=501
I P:0x13A8 o:0 1:27824 f:27874, d:0 st:6 e:01

Data from KB2M

38k4 BBS on AO-51



FileNum	S	To	From	Upload Time	F	Size	%	Title
341	P	ALL	W0SL	0328 22Sep04		83294		My Shack
340	D	ALL	W0SL	0324 22Sep04		505MSG		Uploading Photo
33F	P	N0ZHE	KB2M	0328 22Sep04		358		hello
33E	N			1305 22Sep04		213		EL100922
33D	N			1320 22Sep04		2325		AL100922
33C	N			1302 22Sep04		1060		BL100922
33B	g	PY3VHQ	KE0LX	1754 21Sep04		646		MSG RX'D
33A	D	ALL	KC4LPL	1617 21Sep04		366MSG		test
338	g	PA3FKT	KX4Y	1614 21Sep04		567		Re: Tnx for the call this mor
337	g	PA3FKT	KX4Y	1614 21Sep04		503		32?
335	g	ECHO	KE4AZN	0224 21Sep04		12040		38k4 Test File
334	g	USERS	KE4AZN	0224 21Sep04		649		38k4 Test Info
332	N			0128 22Sep04		498		EL100921
331	N			0055 22Sep04		6231		AL100921
330	N			0002 22Sep04		1760		BL100921
32F	g	PY3VHQ	KX4Y	1658 20Sep04		605		Re: Greetings from Brazil
32E	g	USERS	N4TPY	1652 20Sep04		325		Greetings
32D	D	KD4NEM	N4TPY	1651 20Sep04		324MSG		Hello
32C	D	VK6VV	VK6AKI	1425 20Sep04		557MSG		VK6AKI89.TXT
32B	D	ALL	PY3VHQ	1353 20Sep04		384		Greetings from Brazil
32A	g	UU1JD	PA3GOI	1008 20Sep04		358		Re: Privet
329	D	KX4Y	PA3FKT	1006 20Sep04		545MSG		Re: Tnx for the call this mor

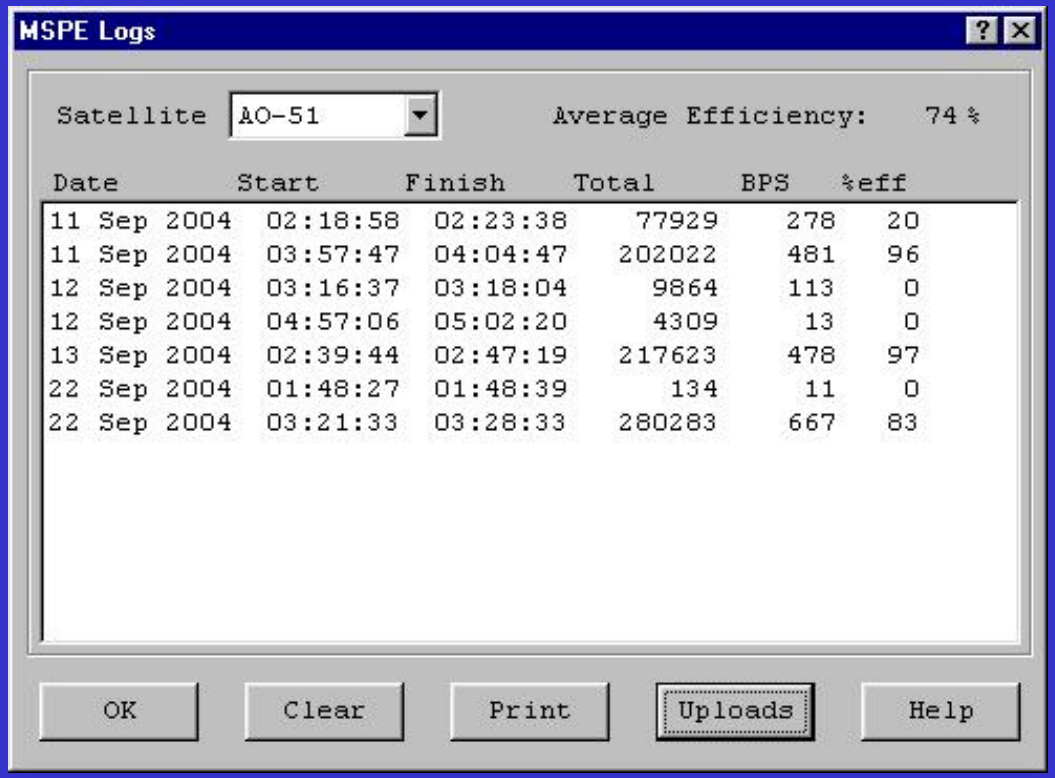
Data from W0SL

38k4 BBS on AO-51

```
I P:0x13A8 o:0 l:27824 f:27852, d:0 st:6 e:01
B: 21726191
PHT: uptime is 032/00:37:40.  Time is Wed Sep 22 15:40:10 2004□
C0:0D C1:44 C2:76 C3:67 C4:04
BCR: batv=1346 bati=107 batsense=50 battop=1346 batlow=1346 batstate=0 sav=1241 sai=452
I P:0x13A8 o:0 l:27824 f:27828, d:0 st:6 e:01
B: 21726191
PHT: uptime is 032/00:38:10.  Time is Wed Sep 22 15:40:40 2004□
C0:0D C1:44 C2:76 C3:67 C4:04
BCR: batv=1352 bati=118 batsense=51 battop=1352 batlow=1352 batstate=0 sav=1241 sai=472
I P:0x13A8 o:0 l:27824 f:27828, d:0 st:6 e:01
B: 21726191
BCR: batv=1355 bati=106 batsense=50 battop=1355 batlow=1355 batstate=0 sav=1240 sai=460
I P:0x13A8 o:0 l:27824 f:27828, d:0 st:6 e:01
B: 21726191
B: 21726191
C0:0D C1:44 C2:76 C3:67 C4:04
BCR: batv=1357 bati=79 batsense=50 battop=1357 batlow=1357 batstate=0 sav=1240 sai=435
I P:0x13A8 o:0 l:27824 f:27830, d:0 st:6 e:01
B: 21726191
PHT: uptime is 032/00:39:40.  Time is Wed Sep 22 15:42:10 2004□
C0:0D C1:44 C2:76 C3:67 C4:04
BCR: batv=1352 bati=47 batsense=50 battop=1352 batlow=1352 batstate=0 sav=1240 sai=396
20SEP04...See Amsat.org for Schedule...AO-51 9K6 BBS OPEN (145.860/435.150)...FM repeat mode OPEN (
I P:0x13A8 o:0 l:27824 f:27830, d:0 st:6 e:01
B: 21726191
PB: Empty.
DIR <Up to Date>   Auto Idle   100%   T: 219532   D:   2400   F: 171388
```

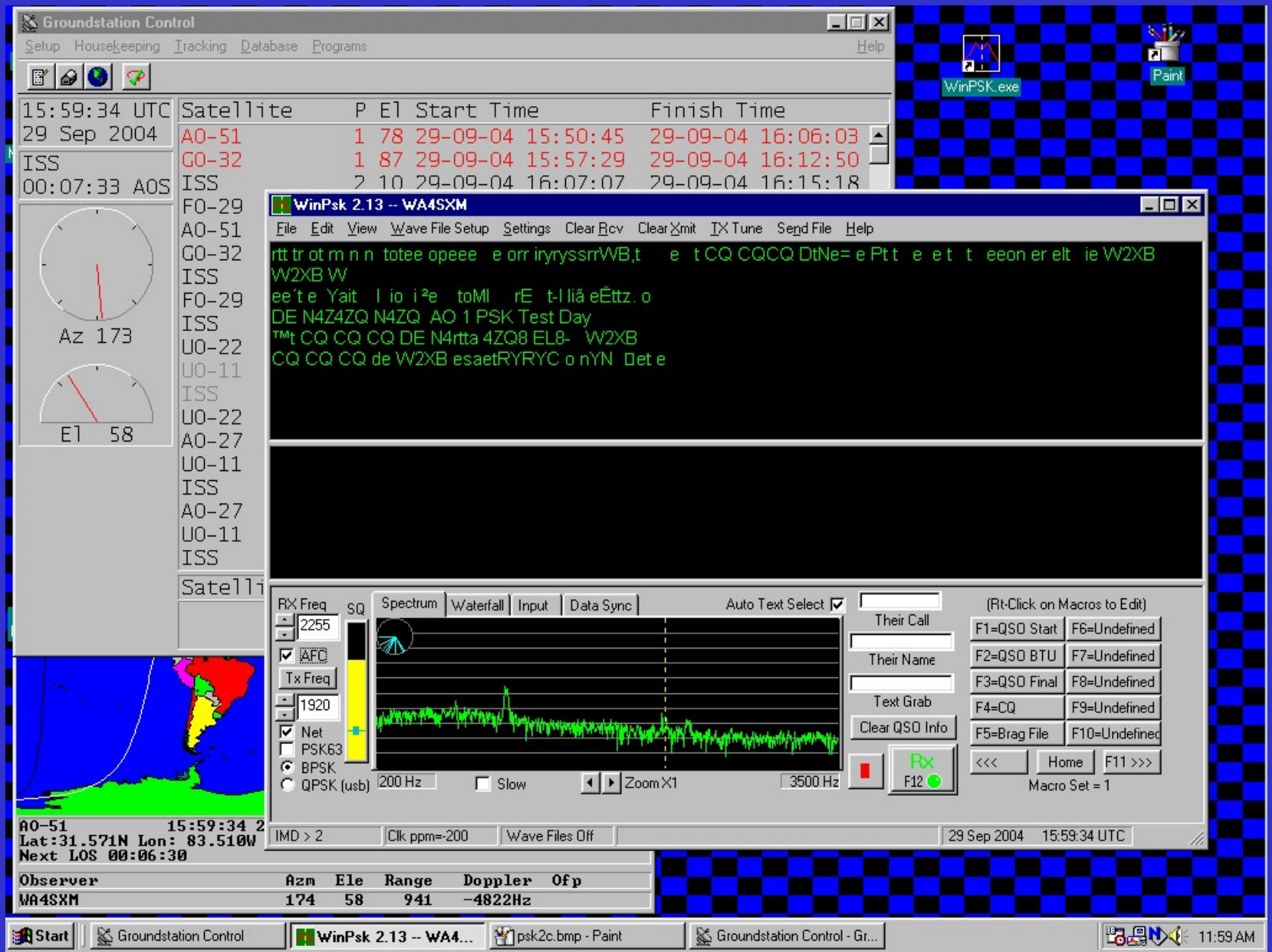
Data from W0SL

38k4 BBS on AO-51

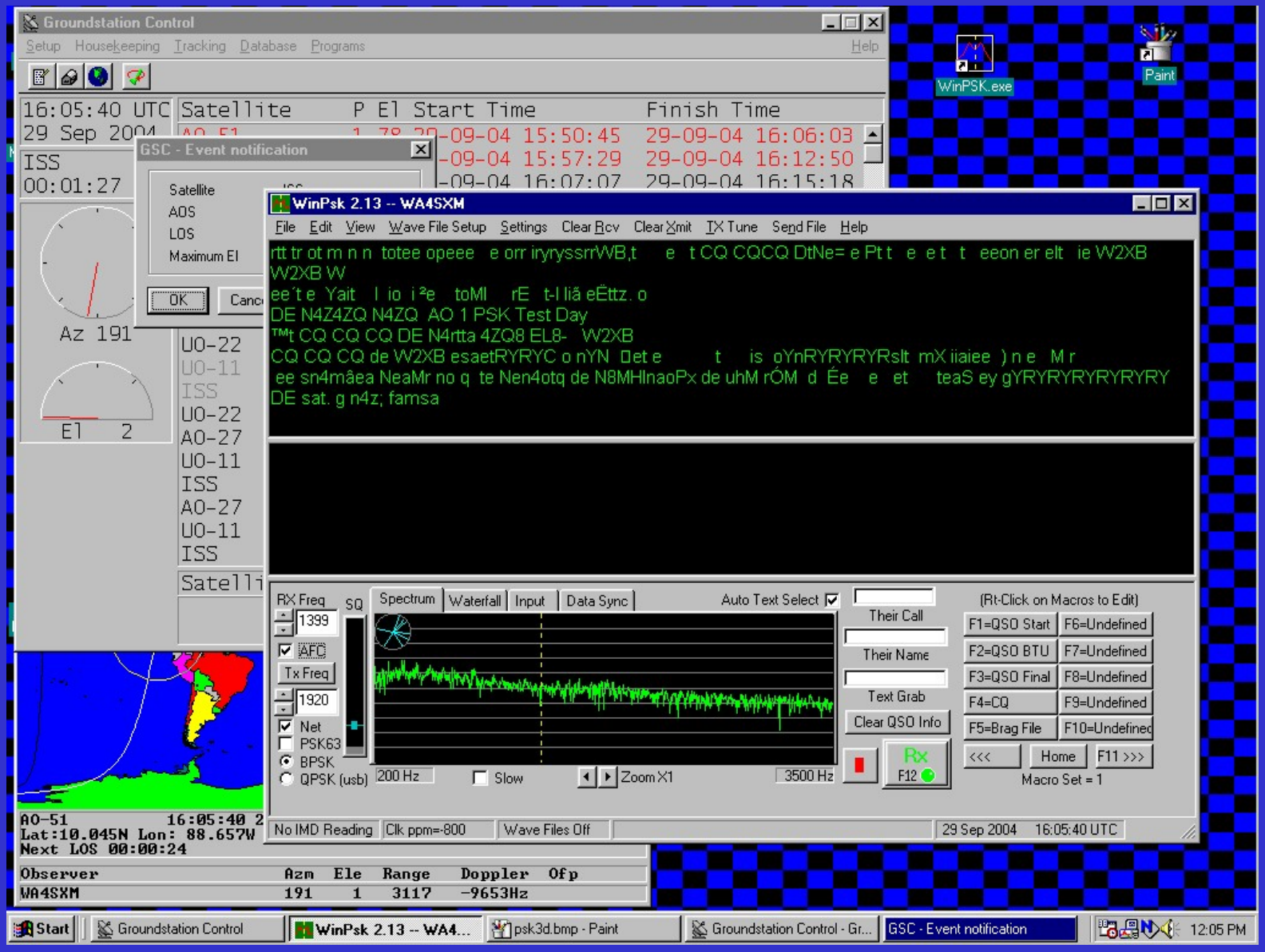


Data from W0SL

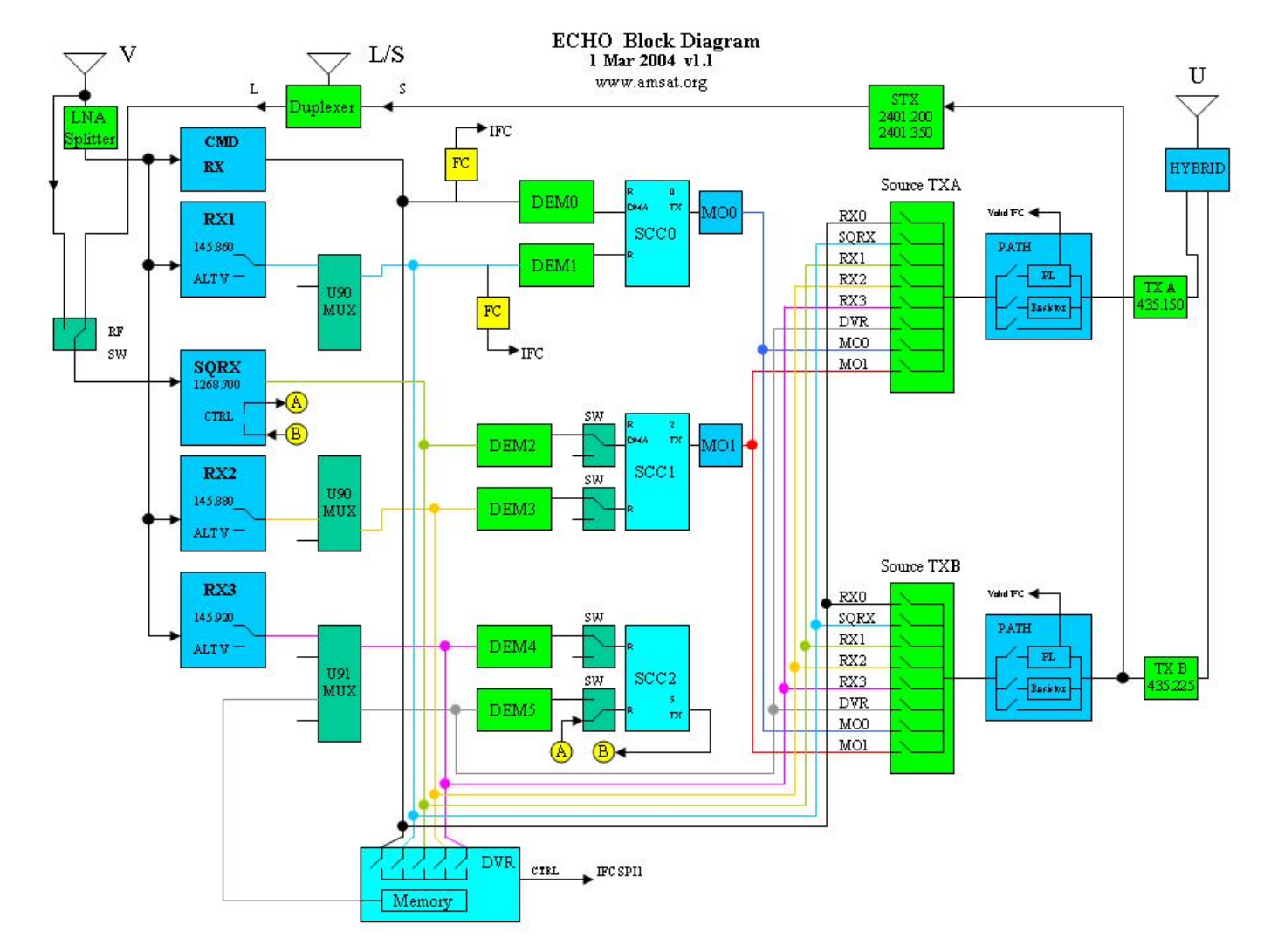
AO-51 PSK31


Groundstation Control
Setup Housekeeping Tracking Database Programs Help
15:59:34 UTC
29 Sep 2004
ISS
00:07:33 AOS
Az 173
El 58
Satellite P El Start Time Finish Time
AO-51 1 78 29-09-04 15:50:45 29-09-04 16:06:03
GO-32 1 87 29-09-04 15:57:29 29-09-04 16:12:50
ISS 2 10 29-09-04 16:07:07 29-09-04 16:15:18
FO-29
AO-51
GO-32
ISS
FO-29
ISS
UO-22
UO-11
ISS
UO-22
AO-27
UO-11
ISS
AO-27
UO-11
ISS
WinPSK.exe
Paint
WinPsk 2.13 -- WA4SXM
File Edit View Wave File Setup Settings Clear Rcv Clear Xmit TX Tune Send File Help
rtt tr ot m n n totee opeee e orr iryryssrrWB,t e t CQ CQCQ DtNe= e Ptt e e t t eeon er elt ie W2XB
W2XB W
ee´t e Yait l io i²e toMl rE t-l liă eËttz. o
DE N4Z4ZQ N4ZQ AO 1 PSK Test Day
™t CQ CQ CQ DE N4rtta 4ZQ8 EL8- W2XB
CQ CQ CQ de W2XB esaetRYRYC o nYN Det e
RX Freq
2255
AFC
Tx Freq
1920
Net
PSK63
BPSK
QPSK (usb)
SQ
Spectrum Waterfall Input Data Sync
Auto Text Select
200 Hz
Slow
Zoom X1
3500 Hz
Their Call
Their Name
Text Grab
Clear QSO Info
Rx
F12
(Rt-Click on Macros to Edit)
F1=QSO Start F6=Undefined
F2=QSO BTU F7=Undefined
F3=QSO Final F8=Undefined
F4=CQ F9=Undefined
F5=Brag File F10=Undefined
<<< Home F11 >>>
Macro Set = 1
IMD > 2
Clk ppm=-200
Wave Files Off
29 Sep 2004 15:59:34 UTC
AO-51 15:59:34 2
Lat:31.571N Lon: 83.510W
Next LOS 00:06:30
Observer Azm Ele Range Doppler Ofp
WA4SXM 174 58 941 -4822Hz
Start
Groundstation Control
WinPsk 2.13 -- WA4...
psk2c.bmp - Paint
Groundstation Control - Gr...
11:59 AM

AO-51 PSK31


Groundstation Control
Setup Housekeeping Tracking Database Programs Help
16:05:40 UTC
29 Sep 2004
Satellite P El Start Time Finish Time
29-09-04 15:50:45 29-09-04 16:06:03
29-09-04 15:57:29 29-09-04 16:12:50
ISS
00:01:27
GSC - Event notification
Satellite
AOS
LOS
Maximum El
OK
Az 191
El 2
UO-22
UO-11
ISS
UO-22
AO-27
UO-11
ISS
AO-27
UO-11
ISS
WinPsk 2.13 -- WA4SXM
File Edit View Wave File Setup Settings Clear Rcv Clear Xmit TX Tune Send File Help
W2XB W
DE N4Z4ZQ N4ZQ AO 1 PSK Test Day
CQ CQ CQ DE N4rtta 4ZQ8 EL8- W2XB
CQ CQ CQ de W2XB
DE sat. g n4z; famsa
RX Freq
1399
AFC
Tx Freq
1920
Net
PSK63
BPSK
QPSK (usb)
SQ
Spectrum Waterfall Input Data Sync
Auto Text Select
200 Hz
Slow
Zoom X1
3500 Hz
Their Call
Their Name
Text Grab
Clear QSO Info
Rx
F12
(Rt-Click on Macros to Edit)
F1=QSO Start F6=Undefined
F2=QSO BTU F7=Undefined
F3=QSO Final F8=Undefined
F4=CQ F9=Undefined
F5=Brag File F10=Undefined
<<< Home F11 >>>
Macro Set = 1
No IMD Reading
Clk ppm=-800
Wave Files Off
29 Sep 2004 16:05:40 UTC
AO-51 16:05:40
Lat:10.045N Lon: 88.657W
Next LOS 00:00:24
Observer Azm Ele Range Doppler Ofp
WA4SXM 191 1 3117 -9653Hz
WinPSK.exe
Paint
Start
Groundstation Control
WinPsk 2.13 -- WA4...
psk3d.bmp - Paint
Groundstation Control - Gr...
GSC - Event notification
12:05 PM

AO-51 Mode Possibilities

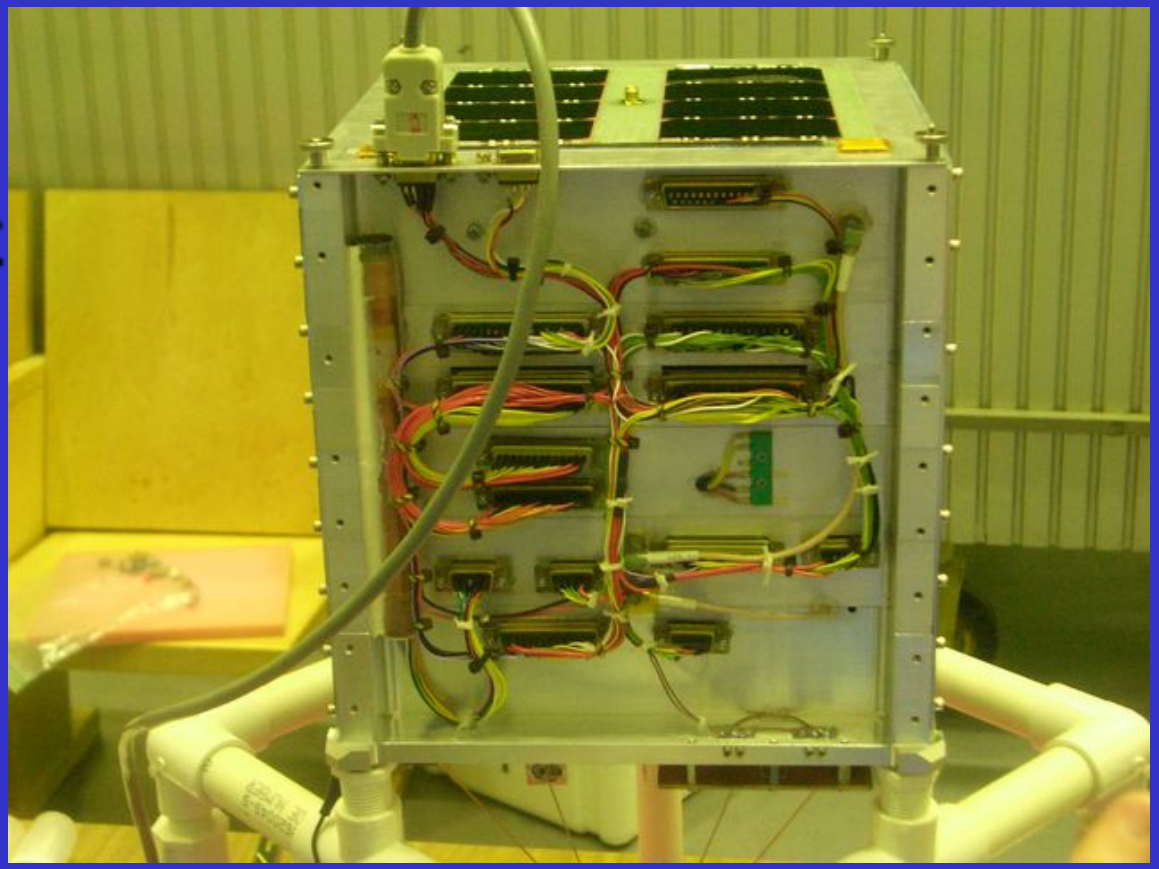


Additional Experiments

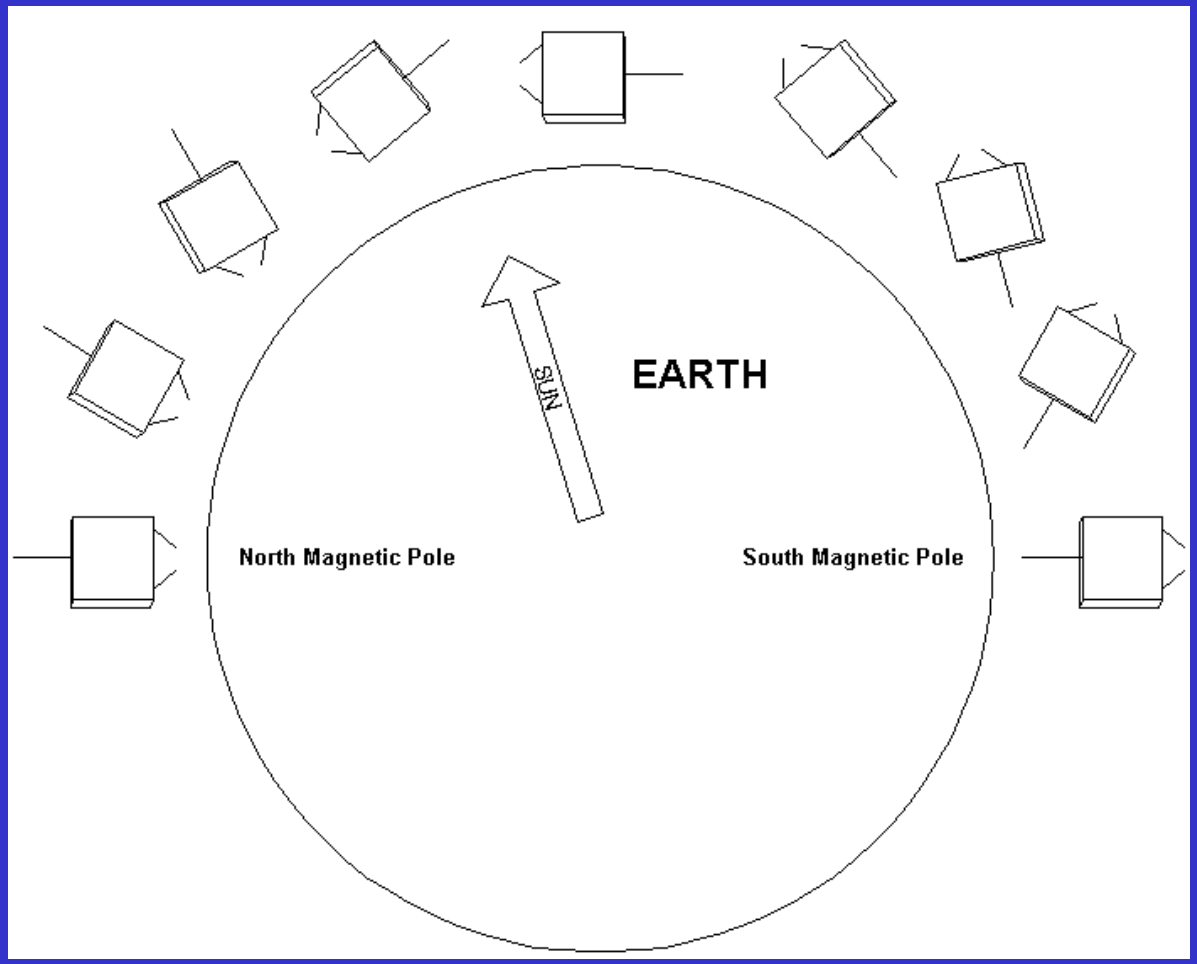
- **APRS** systems display a 20 characters status message when received
- Multiple uses for the SQRX receiver, it receives from 10 MHz to 1.3 GHz; AM, FM, CW, SSB
- Torquer experiments
- Modes and experiments are limited by YOUR imagination

AO-51 Torquer (Attitude) Control

- Active magnetic attitude control.
- Semi-permanent magnetic rods
- Strength and polarity can be adjusted



ECHO Basic Attitude Change



AO-51

Truly a satellite for all amateurs, if they are willing to learn new modes

Questions?